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POWER

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POWER GENERATION
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October, 1935

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POWER

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PHILIP W. SWAIN, *Editor*

NEW MACHINE AGE

SOMETHING that happened in Cleveland last month will leave its imprint on the industrial history of the United States for years to come. I refer to the Machine Tool Show in the great municipal auditorium. Whether he knew it or not, every American citizen, every engineer, had a big stake in that tremendous affair.

After a week in Cleveland the show is vividly in my mind as the most significant industrial event of the year, an amazing display of mechanical progress.

Let's assume that you are, as I am, well acquainted with the good old standard machine tools—lathe, planer, shaper, drill press, grinder, miller—but have not closely followed the spectacular improvements of recent years, particularly those since 1930.

You walk into this Cleveland show and view today's machine tools in operation, $4,000,000 worth of intricate mechanism, covering five acres of floor space. You find everything changed—nothing as it used to be in the old-time shop. Great machines worth $30,000 each perform tasks of unheard-of delicacy, with unheard-of speed. Half-horsepower motors open and close lathe chucks, to save machine time. Tool tips of rare-metal carbides, costing $400 a pound, rip off 25 lb. of steel turnings in one minute. Oil pressure operates hydraulic feeds and cutting drives. An operator plays a 16-button portable switchboard as one would play an accordion, to manipulate the heavy parts of his ten-ton milling machine. The laborious work of the die cutter is replaced by a machine whose delicate finger traces in three dimensions the outline of a model die and makes another like it without the aid of human hands.

These and scores of other sensational developments are no mere mechanical stunts. They are proof that the machine age has shifted to high gear and is ready to "step on the gas" in a new burst of speed. The new machine tools displayed at Cleveland will produce better machines and dies at lower cost. These in turn can and will flood the country with better and cheaper consumer goods of every description.

It should be clear to all that America will soon demand more power than we have dreamed of—first to operate the millions of new mechanical and electrical devices sold for service in homes, buildings and institutions—secondly to roll, rip, cut, grind, press, stamp and weld the endless stream of parts needed for the production of these same devices.

The American genius of tool construction has shown the world at Cleveland the new wonders of the machines that make machines. In another year an equal genius may present in the 1936 Power Show a comparable demonstration of what American ingenuity has done for those power machines without whose service all other machines are but dead museum pieces.

Philip Swain

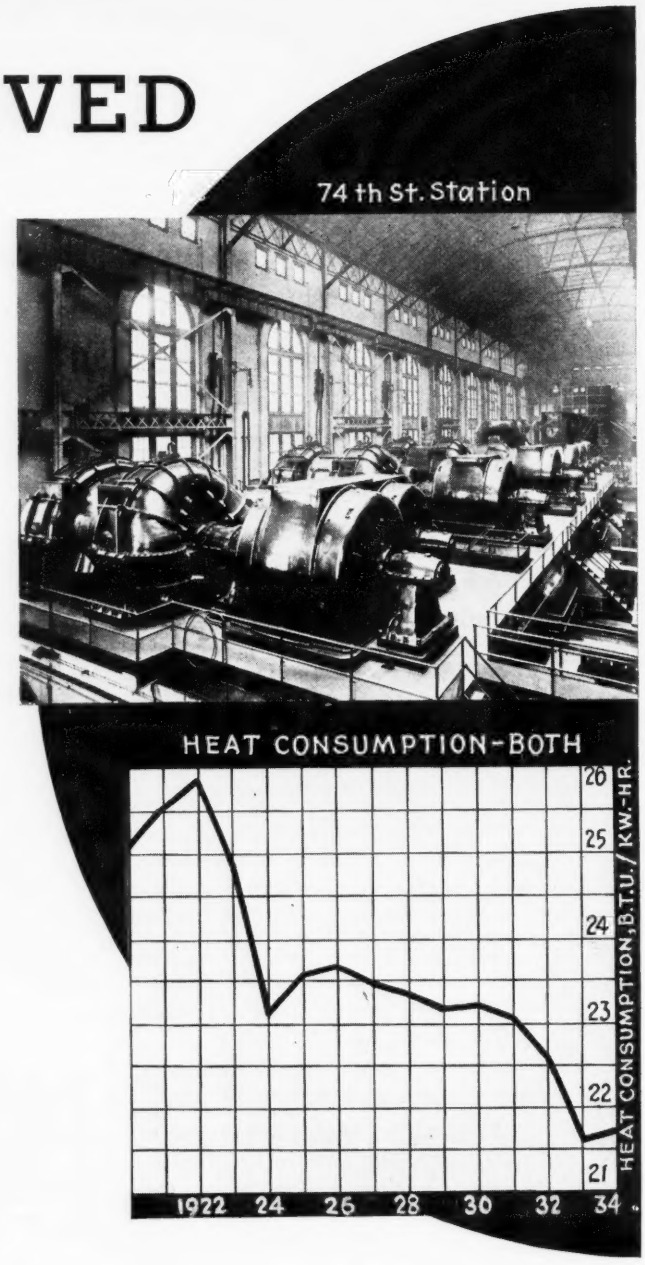
Editor

$7,000,000 SAVED

Improved operation did it for Interborough Rapid Transit Co.

By Herbert B. Reynolds

Mechanical Engineer
Interborough Rapid Transit Co.



MOST engineers believe that all power stations more than ten or fifteen years old are obsolete and should be replaced. This does not apply to the 59th and 74th St. stations of Interborough Rapid Transit Company, New York, N. Y., where the average age of prime movers is over twenty years and boiler equipment is much older. Whole-hearted co-operation between Operating and Engineering Divisions of the Motive Power Department, plus executive backing, results in efficient operation at these plants with existing equipment.

Most of the equipment has already been described. The stations were initially equipped with a great many small boilers and engine-driven generators. All original boilers are still in service, carrying most of the load. Only four boilers have been added. Fuel-burning equipment was either hand-fired grates or Roney stokers, but in most cases has now been replaced by underfeed stokers.

Initially there were seventeen engine units, twelve still in commission for peak-load and emergency service. In 1909, low-pressure turbines were added to the exhaust of five engine units and double Roney stokers were installed under eighteen boilers at 59th St. The combination engine-turbine units are still in use for regular morning and evening peaks. The last major additions were made during 1914-1919, when underfeed stokers were substituted for most of the Roney stokers, and three 30,000-kw. and one 60,000-kw. turbines were added at 74th St., and three 35,000-kw. units at 59th St.

Three of the charts on page 516 give performance of the 59th St. equipment, which is fairly similar to that at 74th St., except for the lack of engine-turbine units there. On the same page is the heat balance of the stations, the simple open-heater system in general use in power stations fifteen years ago. Although most auxiliaries are steam driven, their exhaust supplying steam for feedwater heating, the main units have automatic extraction and injection connections to maintain feedwater at a constant high temperature to reduce steam loss to atmosphere. These connections are of great value in stations supplying a railway load swinging constantly between wide limits, while the amount of auxiliary steam available for feedwater heating remains fairly constant.

Fifty-ninth St. station has both turbine-driven and motor-driven exciters. Shifting the load on these units helps in maintaining correct heat balance, a signal system having been installed to aid in distribution of load. A typical weekday load curve is shown on page 516.

After completion of the major construction work in 1919, the Mechanical Engineering Division began to devote much of its time to studying ways to improve operating efficiency. This has reduced coal rate 17% since 1922 without major equipment changes. Annual savings for 1934 were $850,000 and accumulated savings from 1922 through 1934 nearly $7,000,000. A coal price increase in 1934 increased the annual savings without a decrease in coal rate, although of course it costs more to generate power.

Space does not permit detailed description of each

change or improvement made to bring about these savings. Some of the more important changes are:

1. Testing of coal: Capacity and efficiency tests are made on coals before placing contracts.

2. Distribution of coal throughout plants so that coals of the same characteristics are assigned to definite bunkers: Gives more uniform operation and increased efficiency.

3. Periodic instruction of boiler-room operators: Talks are given to operators on methods of operating stokers and boilers.

4. Loading boilers according to a schedule: All boilers are operated in accordance with a schedule which takes efficiency into account. Reduces coal consumption about 5%. Method of preparing such a schedule was described by the author in an article in *Power*, Oct. 8 and 15, 1929, "How to Prepare a Schedule for Economic Boiler Loading."

5. Installation and use of combustion meters: Boilers had been provided with steam flowmeters and the usual draft gages. In 1923 one combustion meter of the steam-flow, air-flow type was installed and operated for a period with the chart covered. Later the chart was uncovered and the operators instructed as to the use of the meter. By comparing the performance of the boiler while the chart was covered with that when operating by the meter, it was found that the use of the meter greatly improved performance. This resulted in the purchase of combustion meters for all boilers and brought about a reduction in coal consumption of about 3%.

6. Changes in the stroke of secondary rams on the underfeed stokers: Stoker performance was improved slightly by reducing the travel of the secondary rams.

7. Routine tests and inspections of boilers and stokers to check maintenance.

8. Improvement in design of stoker parts: It is estimated that improvements made by the operating division resulted in a 2% reduction in coal consumption.

9. Rearrangement of boiler baffles: Tests were conducted to determine the most efficient baffle arrangement, and all baffles were modified accordingly.

10. Installation of over-fire air nozzles in the front wall of some boilers: Primarily for the purpose of reducing smoke. It no doubt increased the efficiency slightly.

11. Replacement of some Roney stokers with second-hand underfeed stokers, 74th St. station: Necessitated by the demand for additional capacity, this brought about some increase in efficiency.

12. Revamping of existing superheaters, 59th St. station: When superheaters were added to existing boilers at the time the turbines were installed the amount of surface was limited by the space available. Later, it was found possible to increase the surface.

13. Replacement of a number of reciprocating boiler-feed pumps with centrifugal pumps: Lower maintenance cost as well as a slight increase in efficiency.

14. Installation of four 11,400-sq.ft. boilers at 59th St. station: Increased load caused the installation of four additional boilers in 1923. However, the gain in efficiency obtained was offset by the removal of economizers on old boilers to provide room for cinder traps.

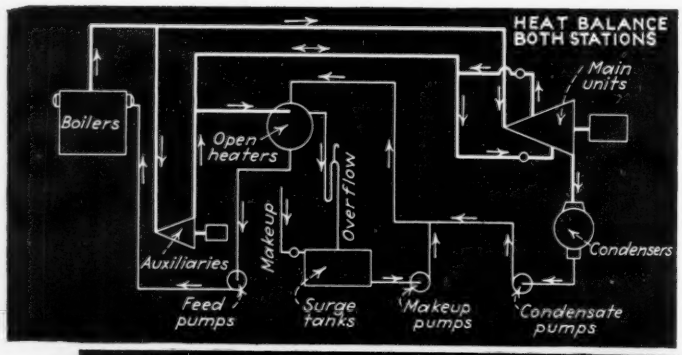
15. Installation of water-cooled walls in the 11,400-sq.ft. boilers: Slight improvement in efficiency and reduced maintenance cost.

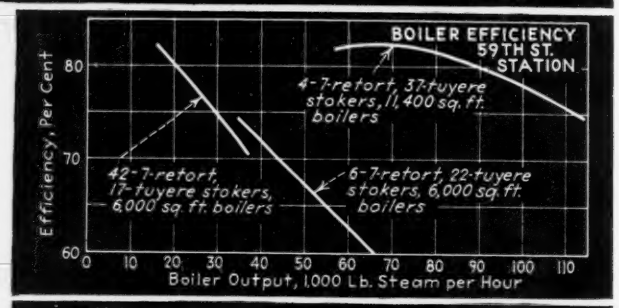
16. Raising feedwater heaters, 74th St. station: Open feedwater heaters were raised about 12 ft. to prevent the feed pump from becoming steam-bound.

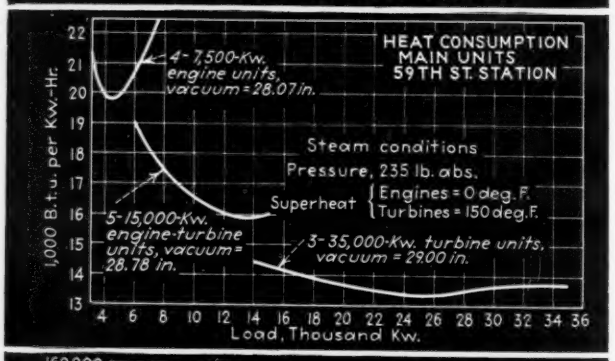
17. Improvement in feedwater treatment.

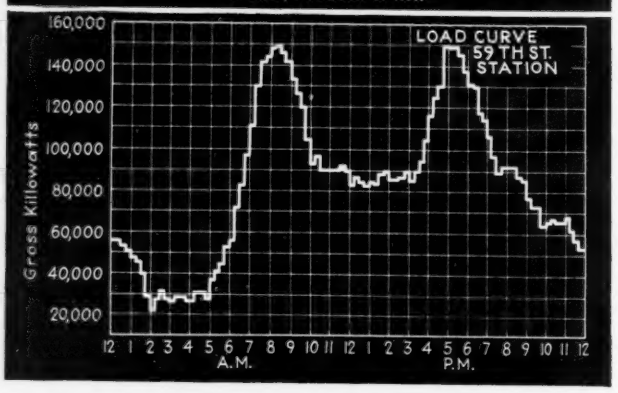
18. Use of turbine loading schedules: Provide for economic loading of main units.

19. Use of a schedule for operation of circulating




BOILER EFFICIENCY
59TH ST. STATION
4-7-retort, 37-tuyere stokers, 11,400 sq. ft. boilers
42-7-retort, 17-tuyere stokers, 6,000 sq. ft. boilers
6-7-retort, 22-tuyere stokers, 6,000 sq. ft. boilers
Efficiency, Per Cent
Boiler Output, 1,000 Lb. Steam per Hour





water pumps: Schedule tells operators when to use one or two of the constant-speed circulating water pumps on the main unit, depending upon the water temperature and the load, in order to obtain maximum efficiency.

20. Redesign of low-pressure nozzles on 35,000-kw. turbines, 59th St. station: Improved turbine performance by replacing low-pressure nozzles with nozzles of improved design.

21. Routine tests of main units and auxiliaries to check maintenance.

22. Improved operation of governors on main units: Erratic distribution of load between units was caused by non-uniformity of governor settings. All governors were adjusted to give a more stable condition.

23. Installation of new oil coolers, 59th St. station: Larger oil coolers were installed on the 35,000-kw. units so that condensate, instead of city water, may be used at all times.

24. Installation of bleeder connections on main turbines.

25. Installation of improved intake screens, 59th St. station: Resulted in cleaner condensers and increased vacuum.

26. Installation of chlorinating plant for 35,000-kw. unit, 59th St. station: An increase of about 0.2 in. in the vacuum resulted.

27. Improved methods of cleaning condensers not served by chlorinating plants: Experiments are now in progress using chloride of lime solution and dry chlorine gas in the water spaces of the condensers, instead of rubber plugs.

28. Improvement in condenser tube layout: Slight increase in vacuum and amount of sub-cooling of condensate reduced by removing a number of tubes from the condenser.

29. Installation of steam-jet vacuum pump: Replacement of hydraulic vacuum pumps on 60,000-kw. unit at 74th St. station reduced maintenance cost and steam consumption and gave better vacuum in the

Table I—Present Equipment

BOILER ROOMS

No. of Units	Boilers: Heating Surface, Sq. Ft.	Boilers: Initial Operation	Type	Stokers: No. of Retorts	Stokers: No. of Tuyeres	Initial Operation
			74th Street Power Station			
6	6,000	1904	Roney	..	....	1904–07
64	5,200	1901–03	Underfeed	7	17	1913–29
			59th Street Power Station			
12	6,000	1904–06	Double Roney	..	....	1907–08
42	6,000	1904–06	Underfeed	7	17	1913–18
6	6,000	1904–06	Underfeed	7	22	1917–19
4	11,400	1924–25	Underfeed	7	37	1924–25

TURBINE ROOMS

No. of Units	Type	Capacity, Kw.	Type of Condensers	Initial Operation
		74th Street Power Station		
3	Engines	7,000	Barom.	1901–02
1	Turbines	7,500	Surf.	1904
3	Turbines	30,000	Surf.	1914–15
1	Turbines	60,000	Surf.	1918
		59th Street Power Station		
4	Engines	7,500	Barom.	1904–06
5	Eng. turb.	15,000	Surf.	1904–11
3	Turbines	35,000	Surf.	1918–19

Table II—Actual vs. Ideal Operation—1934

	74th St.	59th St.
Net output of station, kw.-hr.	626,713,940	549,196,900
Maximum hour load, kw.	147,320	152,515
Load factor, per cent	48.6	41.1
Temp. of circulating water, deg. F	55	57
B.t.u. per lb. of coal (moist)	14,120	14,256

	74th St. Actual	74th St. Ideal	59th St. Actual	59th St. Ideal
Auxiliary power consumption, kw.-hr.	2,453,960	3,033,900	7,536,060	6,839,600
Temp. of feedwater, deg.	215	220	213	215
Press. of steam, lb./sq.in. gage	204	200	213	220
Superheat at turbine throttle, deg. F.	155	160	131	138
Average vacuum, in. Hg.	28.69	28.99	28.57	28.79
Temp. of condensate, deg. F	83	81	82	83
Coal consumption, lb./kw.-hr.	1.519	1.276	1.540	1.330
Heat consumption, B.t.u./kw.-hr.	21,440	18,024	21,966	18,966
Station efficiency, per cent	15.92	18.94	15.54	18.00
Station operating factor	0.840		0.864	
System coal consumption, lb./kw.-hr.	Actual 1.529		Ideal 1,302	
System operating factor		0.851		

condensers which are served by these pumps.

30. Overhauling pipe covering.

31. Recovery of water from drips and drains: Wherever possible, water from drips and drains is returned to the surge tanks, reducing make-up.

32. Use of tie line between two power stations: Judicious use of tie line, which has a 15,000-kw. continuous rating, and 30,000-kw. short period rating, results in reducing fuel consumption by about 1%.

Table II gives the most important operating data for 1934 as compared with ideal performance (computed using acceptance test performance of individual units as a basis, without introducing a factor to cover miscellaneous incalculable losses, etc.). The operating factor is the ratio between the actual and the ideal efficiency. Although ideal performance will never be equalled in practice, simply because it is impossible to keep all units in new condition and operating under test conditions, we believe it possible to obtain an operating factor of 0.90, which with present equipment would result in an annual coal rate of slightly under 1.50 lb. per kw.-hr. Actual minimum monthly coal rates of 1.451 lb. per kw.-hr. at 74th St. and 1.441 lb. per kw.-hr. at 59th St. have been obtained.

All these savings were accomplished only by the efforts of the present and former members of the Mechanical Engineering Division and with the cooperation of the Operating Divisions.

POWER FROM THE SUN

By E. D. Wilson

Photo Electricity Div., Research Laboratories Westinghouse Electric & Mfg. Co.

IT HAS long been a dream of men to harness the stupendous radiant energy from the sun. Indeed, solar machines have been invented and operated, but the investment per kilowatt output has always been discouragingly high and the absolute efficiency discouragingly low. Thus, when Bruno Lange announced a few years ago that he had obtained appreciable current from an improved photovoltaic cell, the world was once more all agog, and dormant hopes of direct power conversion were again aroused. Yet by his own analysis it turned out that the investment per kilowatt capacity was not competitive with conventional methods of power generation.

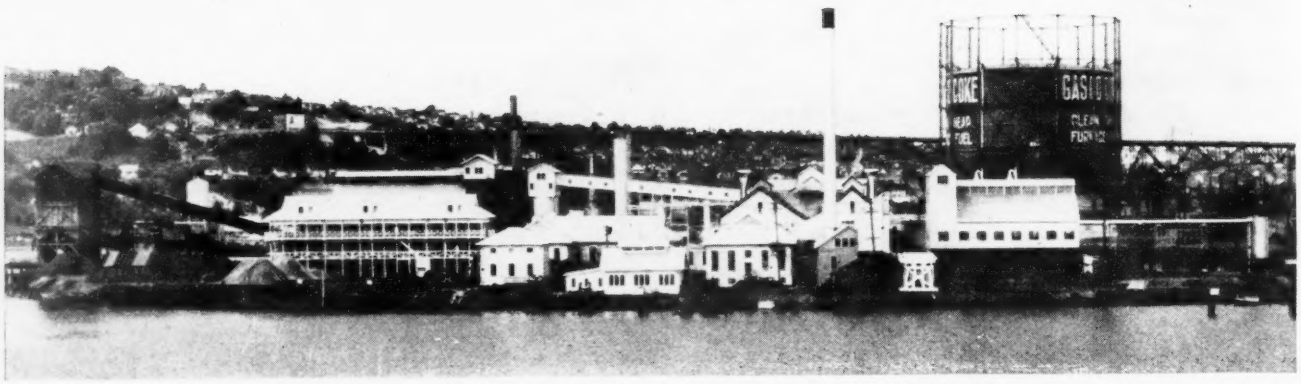
The photovoltaic cell is truly a direct converter of radiant energy into electrical energy. The action of light in the cell is to cause an immediate and continuous displacement of electrons through an internal plane. When the conducting media on opposite sides of the plane are connected externally through a load resistance, a corresponding current flows. When Lange first made his announcement in 1930, the maximum power output of the unit in full sunlight was of the order of one watt per square meter. Although the photovoltaic cell has been greatly improved technically, and its output at low levels of illumination greatly enhanced, it must still be recorded that its rating in direct sunlight remains of the same magnitude.

Mid-summer, mid-day sunlight may approach the value of one kilowatt per square meter on the earth's surface. Thus the over-all efficiency of available cells is about 0.1%. It appears, therefore, that as a power converter the photovoltaic cell will not even prove interesting to the practical engineer until the efficiency has been increased at least 50 times. Even though the efficiency should be magically elevated to 100%, Dr. Abbot has pointed out that it requires 10,000,000 square yards of solar radiation to be equivalent to the potential power of Niagara Falls.

After all, solar radiation is distributed over the face of the earth, and there is no means under the sun by which this dissipation can be undone. To convert any finite fraction of the energy requires a receiving unit of proportional area. And what could be a more satisfactory solution than to allow the far-flung radiation to evaporate water and raise it by convection currents above the hills, then let it condense and fall on the watersheds to be directed to the rivers that lead through giant turbine-generators?

The fact that the photovoltaic cell does not show promise as a power converter for solar energy does not detract from its great usefulness as an indicator of light intensity. Just as the thermometer is a convenient instrument for temperature indication, the photovoltaic cell is a logical and convenient instrument for the measurement of light. Its power efficiency will certainly be greatly improved, but never enough to compete with natural conversion of solar heat.

The author with one of his earlier cells



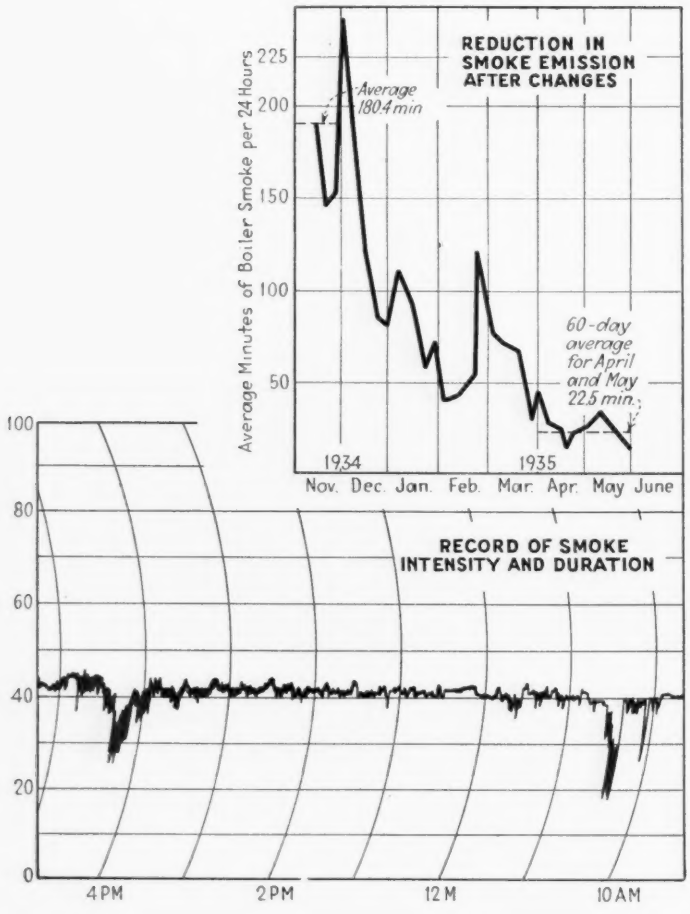
Seattle Gas Co. plant on Lake Union. The gas holder is also aluminum-painted now

SEVEN-EIGHTHS LESS SMOKE

Average smoke emission reduced from 7 min. per hr. to 0.95 min. by installation of smoke alarms and higher stack

By James F. Pollard

Vice-President and General Manager, Seattle Gas Co., Seattle, Wash.



BACK in 1906, when the Seattle Gas Company built its original plant on the north shore of Lake Union, there were but few scattered residences in the surrounding area, and the district was recognized as an industrial zone. Since that time, however, the hills which surround the plant on three sides have been gradually built up by residential developments, and the smoke problem has assumed more serious proportions.

Although the City of Seattle does not have a smoke ordinance, emission of smoke from the plant stack was recognized as a decided threat to company goodwill. Indeed, it finally led to an appeal to the City Council to compel the company to remove its plant to some distant location.

In the fall of 1933, the management began a definite program of plant improvement intended in large part to eliminate the smoke nuisance, though the net effect was also to give the company a more efficiently operated boiler plant.

The initial step was installation of a Weston photronic cell smoke-alarm unit designed to provide an immediate signal upon the presence of smoke in the stack equivalent in density to two Ringelman units. This original "electric-eye" was mounted at one end of a 6-in. pipe in the stack about 10 ft. above the point where smoke enters the stack. A light source was mounted at the other end, with a partially cut-out section of the pipe leaving a space for the smoke to pass between the light source and the photronic cell. As is usual in units of this type, the presence of smoke decreases the light shining on the cell, and results in a decrease in the current which the cell generates. This decrease in current in turn operates a relay which gives the alarm.

A recording voltmeter was also placed in the alarm

circuit, providing a chart record of the frequency and duration of the smoke periods. A check-up made on this equipment to determine the number of minutes per day during which heavy smoke was being emitted showed an average of 7½ min. per hour, or about 3 hours per day.

With this information as a factor, the company reached a decision to install a larger and higher stack. The 70-ft. stack then existing was replaced with a 150-ft. stack, improving combustion and carrying the smoke and stack gases that still remained to higher levels.

Then, in the fall of 1934, as a result of the value of the original smoke-alarm unit, a final attack on the problem was made by means of individual smoke-alarm units on each of the boilers operated at the plant, as well as in the stack itself.

The boiler plant consists of nine 1,500-sq.ft. h.r.t. boilers, eight of which are in double settings and one, single. They are mounted in two banks, one of five and one of four. Three boilers are arranged for oil firing. The balance are equipped with stokers for solid fuel, and tar is also used in these boilers.

By mounting a smoke alarm immediately above each boiler, it becomes possible to detect the exact source of the smoke at once, before a long column of smoke has reached the stack.

In installing these units in such close proximity to the boiler, the problem of protecting them from heat came to the fore. This was solved by the mounting shown in the upper photograph below. The pipe holding the photronic cell extends out about 3 ft. from the front of the boiler, and the visor of the cell is set in a wooden block for heat insulation. Air vents around the visor permit air to rush in toward the boiler, helping to cool the pipe and keep it clean.

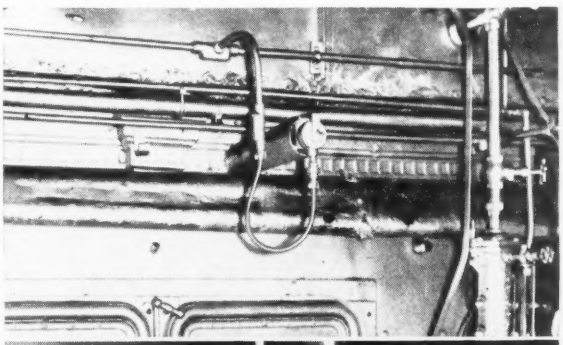
The cell is hinged to the visor at the top, so that when it is necessary to clean the glass cell window, it is only necessary to loosen a thumbscrew, move the clamp sideways and lift up the cell without moving the visor from its position.

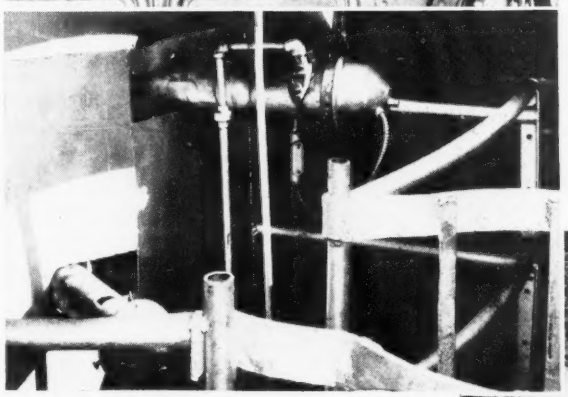
The smoke-alarm unit installed in the new stack has the light source at one side of the stack and the cell on the opposite side. Both the light source mounting and the cell mounting on the opposite side have a small jet of compressed air impinging on the glass surfaces to prevent the accumulation of soot or cinders. In addition to an alarm relay, the stack installation is also coupled to a recording micro-ammeter. Thus a definite record is secured of the *intensity* as well as the duration of smoke emission. (See chart.)

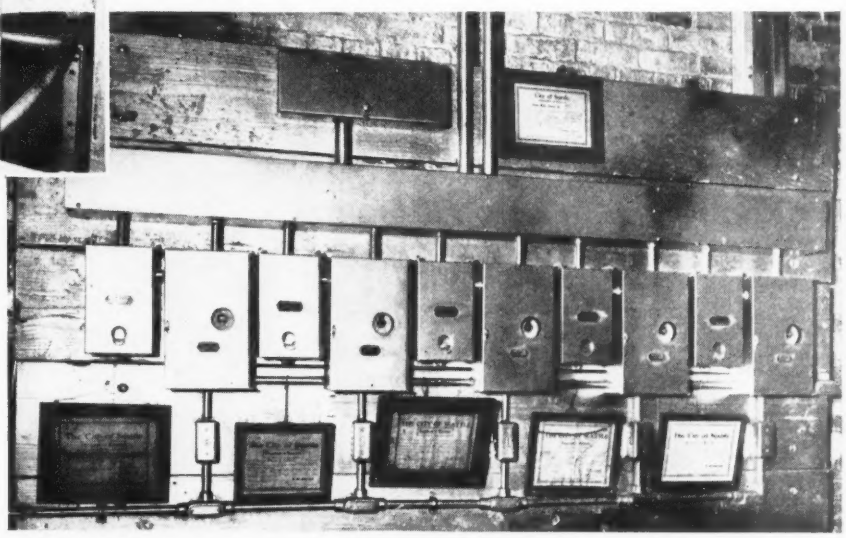
In the banks of relay panel boxes, a decrease in current from the photronic cell due to the presence of smoke actuates the specific alarm circuits for each boiler. In the photograph below, the smaller boxes between the relay units contain transformers and controls by which light sources are maintained at a constant value.

From the standpoint of boiler operation, the completed control set-up is proving most satisfactory, the smoke periods having now been reduced to an average of 0.94 min. per hour. Equally important is the changed attitude of the community in view of the concrete effort which has been made to eliminate the source of complaints. Accompanying steps to improve the appearance of the plant have also been taken. Since the photo shown at upper left was taken, the gas holder has also been painted with aluminum.

Recent newspaper reports confirm the fact that the attitude of Community Clubs and other former antagonists of the company has now been converted to one of friendliness and good-will. We feel convinced that the value of this changed attitude, even when reckoned in cold dollars and cents, represents profitable justification for the effort and expense involved.







Top—Photronic cell mounting to protect it from boiler heat. Above—Light-source mountings are protected by extensions and air blast. Right—One of the banks of relay panel boxes. Smaller boxes between contain transformers and controls.

WORM GEARS

Selection . . . Application . . . Maintenance

By M. M. Wills

Engineer, Worm-Gear Dept.
De Laval Steam Turbine Co.

WORM gears for power transmission have been greatly improved during the past few years. Not only have gear designs been advanced, but machines for finishing the teeth to high accuracy are now available, as well as better materials of construction. Owing to its few moving parts, a worm gear is compact and requires small floor space. Because of its mode of operation it is quiet and free from vibration, has a long life and can stand heavy shocks and overloads.

Wherever an electric-motor, steam-turbine or other power-source speed must be transformed, worm gears can generally be used. Many machinery designers find it more economical to use worm-gear speed reducers than to build a special gearbox into their machines. While machinery manufacturers formerly designed and built their own worm gears, it is now recognized that making of high-grade worm gears is a specialty requiring services of experts. It is, therefore, more satisfactory to purchase worm gears from reputable firms specializing in their production.

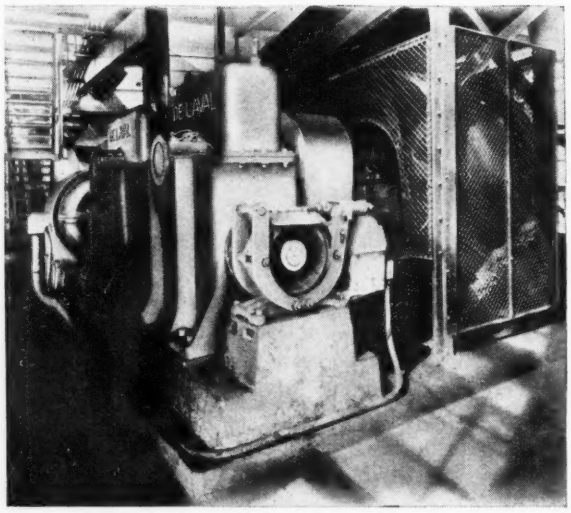
Worm gears are used for all purposes, from operating advertising devices requiring only a small fraction of a horsepower to the severe work of rolling-mill screwing downs in steel plants. They drive paper machines, rubber mills and calendars, ventilating fans, pumps, compressors and agitators. They operate under all conditions of moisture, heat and cold. Many worm gears operate successfully almost buried in dust in cement mills. In Europe they have achieved outstanding success on diesel-engine camshaft drives.

Hundreds of worm gears have been applied to reduce steam-turbine speeds running around 6,000 r.p.m. or higher. At this high speed, when properly designed and lubricated, their operation is quiet and efficient. Worm gears are recommended for speed-up drives where the ratio does not exceed about 10 to 1, although under certain conditions higher ratios can be used.

1-Piece Worm and Shaft

The worm and its shaft are made in one piece from a low-carbon nickel-steel forging. This forging is carburized and heat-treated to develop a hard, wear-resisting surface on the worm threads and a tough, strong core to give strength to the shaft. The gear is made of a special nickel bronze, cast in a chill to increase its density and hardness. In small sizes the rim and center are made in one piece. For larger sizes, a bronze rim is bolted to a heavy cast-iron center.

On the worm the number of threads is controlled



A 150-hp. tandem worm-gear drive on a belt coal conveyor; gear ratio 29.5 to 1

chiefly by the ratio. The designer has little choice. For high ratios, the design is confined to a single thread. For low ratios 10 to 12 threads may be used, since the shape of the gear teeth is too distorted when there are less than about 30 teeth on the gear. A hunting tooth, as in other types of gearing, is desirable to cause each worm thread to come into contact with each tooth of the gear to distribute the wear, increase gear life and insure smooth operation.

Available Ratios

In single-reduction units the ratios generally available range from about 3.5 to 1 up to 80 to 1, ratios as high as 100 or more having been built and operated satisfactorily. Double-reduction ratios are available from about 12 to 1 up to about 6,400 to 1 or more. Single-reduction drives must have their shafts at right angles, but double-reduction drives can be built for right-angle connection or for parallel shafts. The latter arrangement is usually adopted by manufacturers for their regular line. Worm gears are capable of higher ratios than are practicable with other types of gears. Even though their efficiency drops off somewhat at the higher ratios, it still compares favorably with other methods.

For lower ratios, worm-gear efficiencies better than 97% for the drive are obtained. The efficiency is highest when the helix angle is 45 deg. and also at the higher speeds. As the speed drops, the coefficient of friction increases in worm gears just as in other machines.

The chart showing the coefficient of friction as a function of rubbing speed is taken from a recent paper by Dr. S. F. Merritt, of England. Careful input-output tests check the chart closely.

Some engineers think that worm gears are easily made self-locking. While this is true of old-style worm gears, it can no longer be counted upon with modern types. A worm gear to be self-locking must have low efficiency, a condition existing only with rather high-ratio gears when stationary. The coefficient of friction when standing is sufficiently high to make a high-ratio worm gear self-locking. The coefficient of friction drops rapidly with an increase of the rubbing velocity, and the gear efficiency rises so quickly that even at a few revolutions per minute the gear is no longer self-locking. Vibration of adjacent machinery is often sufficient to start a locked gear, and once started it may accelerate. Where a self-locking gear is desired, it is advisable to use a brake which applies automatically when the motor current is cut off. The brake need not have a capacity equal to the motor torque. The torque that must be provided in the brake depends on the gear ratio and the drive characteristics.

Lubrication

The lubricant best suited for worm gears is a high-grade compounded steam-cylinder oil having a viscosity of between 135 and 165 sec. Saybolt at 210 deg. F. The compounding ingredient is usually acidless tallow, which helps the oil to adhere to the surfaces and prevents it from being easily wiped off.

Churning of the oil generates the greater part of the heat produced in a worm-gear speed reducer. Because of its compactness the drive has relatively small radiating surface and the operating temperature may reach 180 deg. F. or higher without harming the gearing. For low speeds, locating the worm beneath the gear is recommended. For input speeds of 1,150 r.p.m. or higher, a worm above the gear will probably operate at a lower temperature than one mounted below.

Where gears are located in exposed places and operation is intermittent, such as operating drawbridges or gates on dams, difficulty may be encountered from frozen oil. This difficulty can be overcome by using oils that remain fluid at low temperatures. If in an unheated place, it is advisable to change oil in all kinds of speed reducers at approach of cold weather. If not removed, moisture accumulates in the gear case and emulsifies with the oil and may freeze.

The standard rating formula of the American Gear Manufacturers' Association has been adopted by practically all reputable worm-gear manufacturers. This A.G.M.A. rating is usually stamped upon the nameplate. The formula assures a uniform method of rating gears and also requires that the materials conform to prescribed standards.

The horsepower rating for Class 1 assumes a service of 8 to 10 hr. daily, free from regular shocks.

Class 2 uses a factor of 1.2 and is intended to take care of shock loads on an 8- to 10-hr. daily schedule, or to take care of 24-hr. service without shocks.

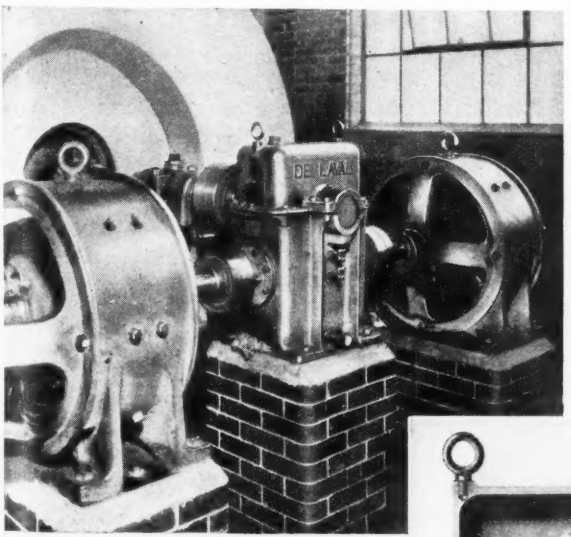
Class 3 uses a factor of 1.33 and covers 24-hr. service with shock loads.

Class 4 is for intermittent loads and uses a factor of 0.7.

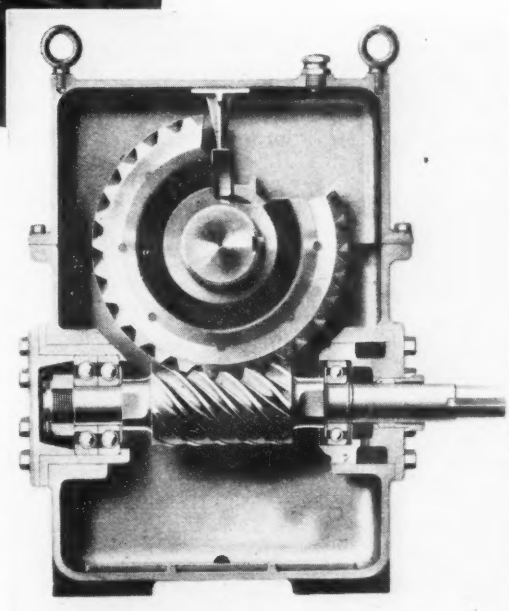
Class 5 covers the low-speed drives where the speed of the worm is less than 100 r.p.m., and is based on torque output rather than hp. input, irrespective of the character or duration of the load.

Specifications

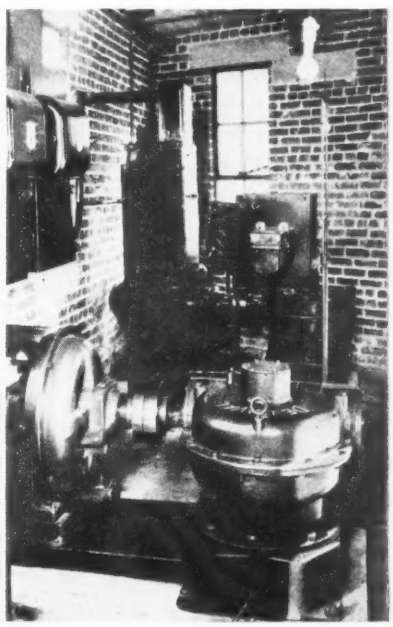
The horsepower-rating tables issued by worm-gear manufacturers are easily understood and can be used by anyone possessed of a little knowledge of mechanical things. The manufacturer or his representative, however, should always be consulted, as his advice



Induced-draft fan driven by worm gear from a 2.5-hp., 600-r.p.m. and a 55-hp., 1,700-r.p.m. d.c. motor



Right — Section through a bottom-drive worm gear



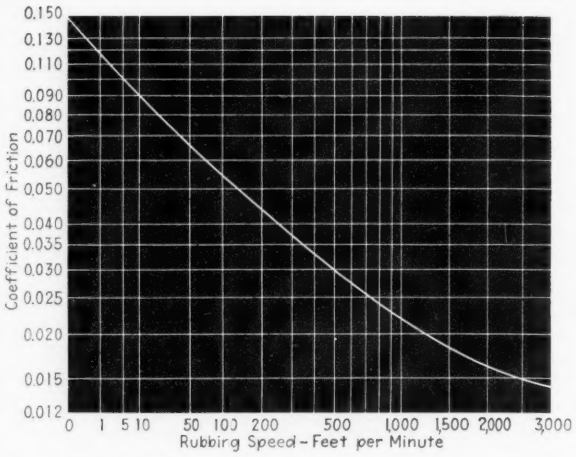
Far Right — Worm gear with 4½ ratio connects 50-hp. motor to vertical-shaft trash pump

may frequently prove quite valuable. Information should be supplied as to the speeds and character of the driving and driven machines, average and maximum loads and their duration, the nature of location, including exposure, temperature, air circulation, etc.

Standard worm gears are available for all powers up to about 400 hp., and for all speeds up to 6,000 to 8,000 r.p.m., although a number have been built for higher speeds.

A worm gear, like other machinery, should be installed on a substantial foundation. A good bedplate is an advantage, although not absolutely necessary. Even though bedplates are used they are flexible and must always be shimmed at several points to get the couplings in good alignment before bolting tight, and this must be checked before starting.

Speed reducers were originally designed for the reception and delivery of power through flexible couplings. Some users wish to mount sprocket wheels, pulleys and even cranks on the gear-wheel shaft. Bearings for such applications are generally designed to carry reasonable overhung loads. In some lines of gears, sleeve bearings of quite generous size make possible the carrying of relatively large overhung loads. In general, however, it is better engineering to use an outboard bearing where possible. Very little attention is required in the operation of a worm gear beyond seeing that it always has sufficient lubrication.



Coefficient of friction as a function of rubbing speed

WHY COMPRESSOR EXPLOSIONS

By A. F. Rieber

St. Louis, Mo.

ALL THE ingredients are present in an air compressor to make it an internal-combustion engine. This is exactly what takes place when an explosion occurs. A compressor is not designed for service as an engine, consequently the results are usually disastrous. Oil is necessary properly to lubricate the moving parts, but take care to select a high-flash point grade. Discharge temperature of a single-stage compressor with intake air at 60 deg. and final pressure 100 lb. will be about 480 deg. Oil must be of a good grade to withstand such temperatures.

It is poor practice to supply good quality oil for air-cylinder lubrication and use cheap oil in the crankcase. Crankcase oil is splashed on the piston rod and carried into the cylinder where it can do a lot of damage if not of good quality.

From Vaporization

Explosions occur sometimes when the best grades of oil are used, usually as a result of an excess of oil. High-flash point oils vaporize to a certain degree at much lower temperatures than indicated by a flash test. If oil in proper amounts is fed to the compressor cylinder, practically all of it will be vaporized in the discharge pipe. The quantity of oil vapor being very small compared to the air volume, the mixture is too lean to explode.

If oil blows out in quantity with the water when the air receiver is drained, it indicates that excessive oil is being used. The oil feed should be cut down until only a trace of oil is found when draining.

Causes

The main causes of disastrous explosions are excessive oil for cylinder lubrication and failure of intake or discharge valves to function properly. If a discharge valve leaks, it permits compressed air at a high temperature to flow back into the cylinder, excluding a proportionate amount of cool intake air. This raises the initial temperature, and upon re-compression, the discharge temperature may be raised to a point at which it will ignite any oil that may be present. If there is a quantity of oil in the receiver, combustion may be so rapid that an explosion results.

I recently had such an experience, but as there was little or no oil in the receiver, an explosion did not occur. A mechanic removed the inlet and discharge valves from a 12x10-in. motor-driven compressor to clean them. When replacing them he did not seat one of the discharge valves on the copper gasket properly. This valve leaked, allowing compressed air to blow back into the cylinder. After the compressor was run about 30 min., the safety valve opened on the discharge pipe, and a jet of flame several feet long issued from it. The compressor was shut down at once, but for 10 min. the safety valve belched sparks

of hot carbonized oil. When the compressor had cooled, the discharge valve was properly seated and no further trouble was experienced.

Dirt taken in with the inlet air is a common cause of leaky valves. This dirt is bonded by the lubricating oil and encrusts the valves, causing them to leak. A leaky inlet valve is almost as objectionable as a leaky discharge valve.

Circulating a soap solution through the piping and compressor is the most practical way to remove excess oil, carbon and dirt deposits. This solution should be made from soap powder that contains a high percentage of alkali. Bar soap and soap flakes are not so satisfactory. Concentrated-lye solutions are recommended by some authorities, but most commercial lyes are made of caustic soda or caustic potash, and are dangerous to handle, while soap solutions are harmless.

Introduce the soap solution directly into the suction or inlet side of compressor while the compressor is running. Ordinarily 0.5 lb. of soap powder to 10 gal. of water is sufficient, but the soap content can be increased to any amount without being harmful. Particular care should be exercised not to feed soap solution too rapidly, as the compressor piston clearance is small, and excess water may crack a piston or cylinder head. A little experimenting will indicate to the operator the proper rate of feed. The soap solution, oil and dirt will collect in the receiver, from which it should be drained.

Soap and Water Good

Soap and water solutions are harmless to air compressors. A solution of pure Ivory soap and water is used for lubricating the cylinders of oxygen compressors. As this oxygen is compressed to 2,000 lb. pressure, ordinary hydro-carbon oils are unsuited because oxygen ignites with hydro-carbons under slight pressure.

A practical method for ascertaining whether compressor valves are tight is to place a thermometer on each valve cap and note the temperature. A valve found hotter than the others indicates it is leaking. One experienced in compressor operation can judge by the sense of touch when a valve is leaking.

These few simple rules for safe compressor operation should be rigidly followed.

Keep the compressor in proper repair.

Keep both intake and discharge valves tight.

Use a good grade of high-flash point oil for cylinder lubrication, and use the same oil in the crankcase.

Pipe the intake to a cool supply of air and use an air filter. Most so-called carbon deposits in air compressors are just plain dirt and dust taken in with the air.

Keep the water jacket free from scale and mud by periodic cleaning. Be sure the safety valve is of sufficient size and located so that it will protect the compressor as well as the receiver.

Flush out compressor and receiver periodically with a soap solution to remove excess oil and incrustation of burnt oil and dirt.

Water-Jacket Scale

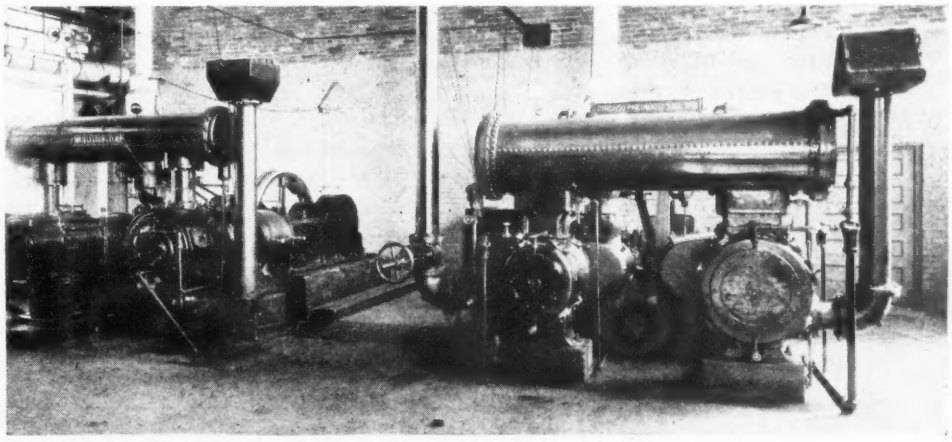
To remove scale from the water jacket, a solution of muriatic acid and water is the most effective. Muriatic acid is the trade name for a 33% solution of hydrochloric acid and water. In case your dealer cannot supply muriatic acid, commercial hydrochloric acid is the same thing and equally effective. The solution should be made up of 50% water and 50% muriatic acid, mixed in a steel or wooden barrel or tank of a size comparable to the water-jacket volume of the compressor. Do not use galvanized or aluminum vessels, for muriatic acid attacks these metals readily and the effectiveness of the solution is reduced.

The solution is circulated through the water jacket. Disconnect the cooling-water lines and pump the solution out of the barrel into the cooling water inlet, through the water jacket, then from the water outlet to the barrel. If a suitable pump is not available, a short length of pipe may be attached to the water inlet with a funnel elevated so that the acid solution will circulate through the water jacket and flow by gravity back to the mixing barrel.

Time to Remove Scale

The time required to remove the scale depends upon the deposit. A good plan is to circulate the acid solution for 10 to 15 min., then let the jacket stand full of solution for 30 min. After this recirculate for another 10 to 15 min. Repeat this process until the jacket is clean or the solution spent. For extremely heavy-scale deposits it is necessary to add more acid to the solution after it becomes spent.

After clearing the jacket of scale, flush it with fresh water to remove the solution. When handling this acid and solution, take all usual precautions. Wear goggles to protect your eyes, and do not spill it on your body or clothing.



Most so-called carbon deposits in air compressors are just plain dirt and dust taken in with the air and can be prevented by installing a filter on the intake pipe

UNTOUCHED BY HUMAN HANDS

Coal from a track hopper is delivered to any one of several silos automatically with this handling equipment

By R. F. Emerson
Industrial Engineering Dept.
General Electric Company

STORING coal in silos has proved to be an economical means of providing a coal supply at power stations. A silo usually comprises a vertical cylindrical tank with a conical bottom. The number of silos may vary from one for small plants to several for large plants. They are located at an elevation so that they discharge directly into a weigh larry for stoker firing or into the pulverizer feeder when coal pulverized is burned.

Getting coal into a silo is a considerably more involved problem than taking it out. Coal is brought in a railroad car and discharged into a track hopper near the silos. If there is more than one silo, the hopper is at the center of the group. To transport the coal from the hopper into the proper silo of a group requires handling equipment that will transport the coal both vertically and horizontally.

A popular method is to use a bucket, lowered beneath the track hopper for loading, after which it is hoisted up an inclined track (photo at upper right). When the bucket arrives at the top, so that it clears the silo tops, the hoisting motion is stopped by means of a limit switch and it is ready to be trolleyed either right or left, depending on the location of the silo being filled. When the bucket arrives over the proper silo, the transverse motion stops and the bucket is lowered until it bottoms on the coal pile. Stopping the bucket automatically discharges the coal through its bottom by tripping a latch. On the return trip, the bucket is reclosed ready to receive another charge of coal when it arrives in the loading pit.

Motor Drives

For operating these equipments, wound-rotor and single-speed and double-speed squirrel-cage alternating-current motors have been used successfully. The type used depends almost entirely on mechanical details of the silo rig and the bucket speed. When an empty bucket is being returned to the track hopper, it must stop accurately over the inclined rails, because the track wheels on the bucket must engage the inclined rails, otherwise the sequence of operations will be upset. For low-transverse-speed silo rigs, it may be possible to use a single-speed squirrel-cage motor and obtain a sufficient accuracy in stopping the bucket over the inclined track.

If a large number of silos are used, the rig may be designed for a high transverse speed. In such installations, a 2-speed squirrel-cage motor or a wound-rotor motor may be necessary so that motor speed can be reduced before a final stop is made. Such a method of stopping is conducive to high accuracy. It may also be found that frequent starting causes undue wear on haulage cable unless motor and control are designed for making a smooth start.

The first silo equipments were designed for hand operation. An operator pressed a start button to run a full bucket up to the trolley runway, where it opened a limit switch to shut down the motor. The operator then pressed another button which trolleyed the bucket over the desired silo where its motion was arrested by a limit switch. Then, the attention of the operator was required for starting the bucket down into the silo. With manual operation, time is lost when the operator's attention is diverted or if he has other duties also. A thoroughly reliable and entirely automatic equipment is not subject to such delays and releases the operator for other work.

Automatic Control

A number of successful automatic equipments are now in operation which are started by throwing a switch or pressing a button. They then make round trips between the loading pit and one particular silo without further attention from the operator. With the bucket in the pit, the operator presses a button. After a time delay to allow the bucket to fill, the motor starts and runs it to the maximum raised position. Here, a limit switch stops the hoist motion and starts the traverse motion. When the bucket reaches the desired silo, a limit switch stops the traverse motion and starts lowering the bucket.

When the bucket hits the coal pile, two operations occur. First, the latch on the bucket trips to spill the coal. Second, the hoist motor is automatically reversed from full speed in one direction to full speed in the reverse direction so that hoisting of the bucket starts immediately. Reversing the motor automatically is usually done by action of a slack-cable limit switch. This switch is operated by the hoist cable becoming slack when the bucket rests on the coal in the silo. If the bucket latch fails to release, some controls are designed so that the bucket is lowered again after raising a few feet and continues to raise and lower until the coal is discharged. This prevents returning a full bucket to the pit and flooding it.

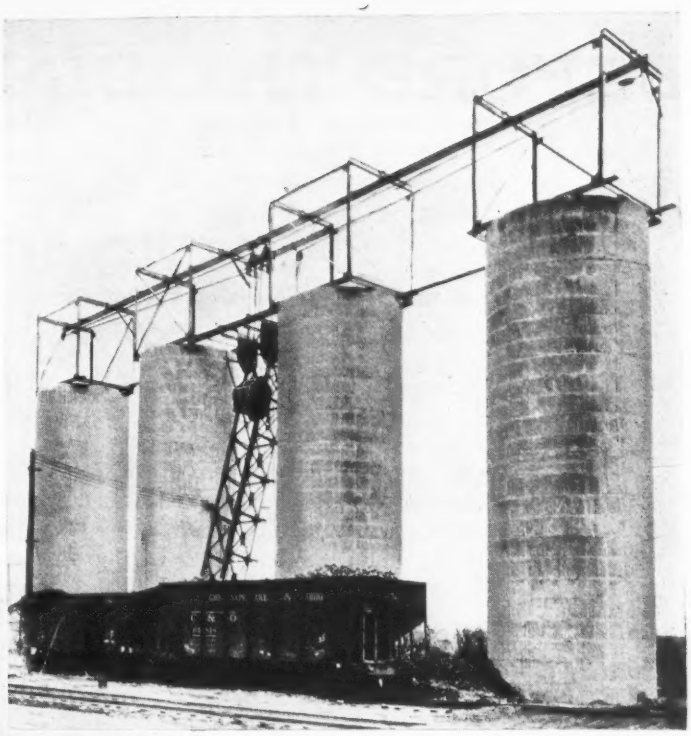
When the bucket comes out of the silo, a limit switch stops the hoisting motion in the maximum raised position and starts the transverse motion. A limit switch stops the trolley motion when the bucket arrives over the inclined tracks and a time-delay relay delays lowering long enough for the bucket to stop swaying. It is important that the bucket be stationary before starting to lower, otherwise its wheels may not engage the rails leading into the loading pit. After about four seconds

delay, the motor starts and lowers the bucket into the pit. The mechanical design of some equipments may be such that this refinement will not be necessary, the hoist manufacturer making use of such electrical control refinements as his experience indicates may be required for the installation.

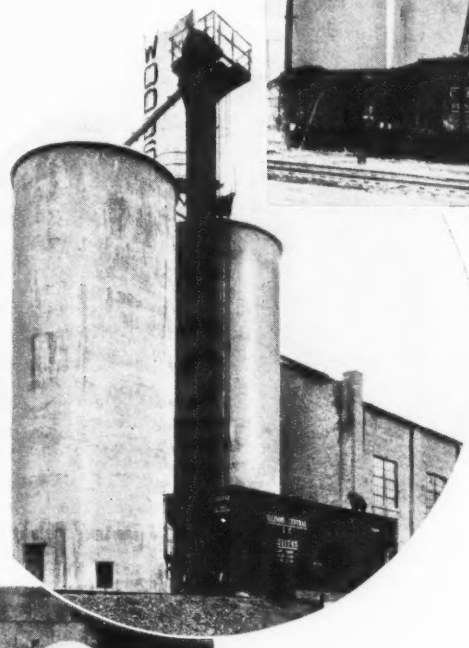
As the bucket goes into the track hopper it engages a latch that opens the bin door, allowing the bucket to fill. About seven seconds will be required to fill the bucket, after which a time-delay relay functions, causing the hoist motor to start up again. The cycle is thus repeated continuously with no attention by the operator. A limit switch is sometimes provided which keeps the bucket from lowering into the pit if it fails to close. After a car has been unloaded, the equipment is stopped, until another car load of coal can be brought over the loading pit by pressing a stop button. If this car of coal is to go into another silo, the operator routes the bucket accordingly by setting the selector switch for that silo before pressing the start button. The dial of the selector switch is at *A*, on the photograph in the lower left-hand corner of this page, which shows the control panel, hoist motor and trolley motor.

Different methods of rope reeving are used for transporting the bucket, all of which have their advantages. One arrangement makes use of a single rope and two drums driven by a single squirrel-cage motor for both the hoist and transverse motions. Hoisting, lowering, and trolleying right or left are accomplished by changing the rotation of the two drums with respect to each other. Another arrangement requires two ropes, one for hoisting and one for the transverse motion, each drum driven by its own motor. In all cases a spring-set, power-released brake is used with each motor so that on failure of electric power, the brake will set automatically and hold the load.

Manufacturers of automatic coal-handling rigs and electrical manufacturers have cooperated in developing these outfits so that reliable equipments are now available.

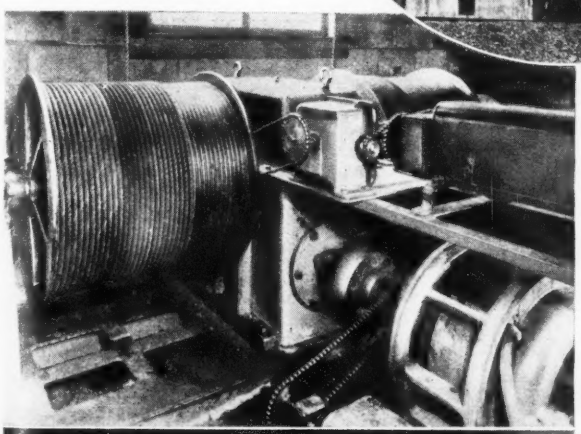


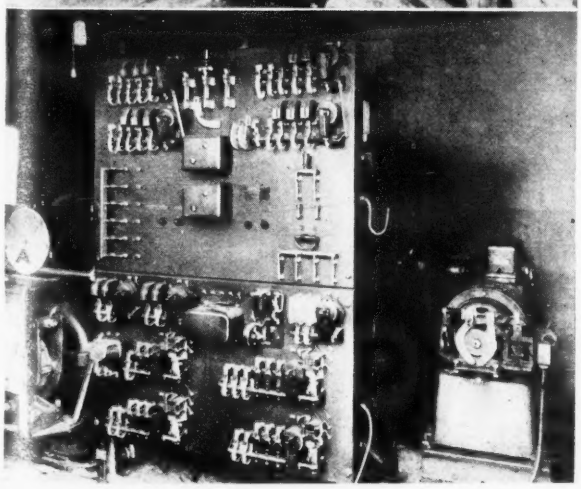
Above — A 4-silo coal-storage plant provided with automatic handling equipment



Below—Power plant for operating silo system comprising two drums, limit switches and operating motor

Circle—Coal- and ash-handling installation at the Municipal Power and Light plant in Woodstock, Ill.





Bottom — Control panel; silo-selector dial switch shown at *A*

BEFORE THE ELEVATOR STARTS

By Charles A. Armstrong

Control circuits for starting the motor-generator set on an Otis 3-M.V.U. unit-multivoltage, car-switch controller

ONE of *Power's* readers writes: "Tell Mr. Armstrong that his explanation of the potential-switch circuit for an Otis type 3-M.V.U. elevator controller in August number is fine, but how about tracing out the starting circuits and show how power is delivered to the control panel from the exciter?" Well, I suppose there is nothing to do but begin at the beginning and tell our friend how the equipment is started.

Starting the motor-generator will depend somewhat upon the type of equipment. In this case, consider a control using a 3-phase, squirrel-cage motor driving a 240-volt direct-current generator and exciter. The motor is started with resistance in series with the stator winding. Fig. 1 is a simplified diagram of the motor and starting circuits. Coils *W* and *U* are series overload relays the contacts of which are in series in the starting circuit. These relays are of the lock-open type and if the motor fails to start when the starting switch is closed in the car, check to see if contacts *Wo* and *Uo* are open.

Starting Circuit

One side of the starting circuit is connected to 3′ line on the left-hand side of overload relay coil *W*, looking at the rear of the control panel, and the other side connects to 2′ terminal at the bottom of the control panel. When the starting switch is closed in the car a circuit is completed from 3′ line through overload contacts *Wo* and *Uo*, coil *S* of auxiliary line switch, the left-hand side of the double-pole knife switch and to *SB*′ terminal at top of the control panel. Leaving the control panel, the circuit goes to the hoistway junction box and into No. 4 traveling cable, through the starting switch and returns by the same route to *SB* on the control panel.

From *SB* terminal on the control panel the circuit goes through contacts *Ma* of the overload protective relay *M* on the elevator motor and returns to *PR* terminal on the control panel, through fuse No. 5 and to 2′ terminal. Energizing this circuit causes auxiliary line switch *S* to close its contacts, *Sa* the right-hand one being in series with coil *K* of the starting switch. The left-hand contacts of switch *S* is in series with the coil of running switch *L*.

Closing *Sa* contact completes a circuit for coil *K* from 3′ line through contacts *Wo* and *Uo* and the right-hand auxiliary contact *La* on running switch *L*, coil *K*, contact *Sa* on the auxiliary line switch, and to terminal *SB* at the top of the control panel. From here the circuit is completed as for coil *S* to 2′ terminal. Putting power on this circuit closes starting-switch contacts K_1, K_2 and K_3 and connects the motor to the line through resistances *A*, *B* and *C*. At one instant the motor circuit is from 1′ line through resistance *A*, winding 1-2, resistance *B* and to 2′ line. The other circuit is from line 3′ through contact K_3, resistance *C*, winding 3-2, resistance *B* to line 2′.

Coil *L* of the running switch is connected directly across the motor terminals on the control panel from 1 to 2 through contact *Sa*′ on auxiliary line switch, and is therefore energized when the starting switch closes. Due to the voltage drop through the starting resistance the voltage across the motor terminals is not sufficient to cause coil *L* to close its switch. As the motor comes up to speed the starting current decreases. This reduces the volts drop across the starting resistance and raises the voltage at the motor terminals.

At about 80% full motor speed, the voltage across the motor terminals reaches a value that causes running switch *L* to close and connect the motor to the line, and it comes up to full speed. Switch *L* has two auxiliary contacts; the right-hand one *La* is in series with the starting switch coil *K*. When the running switch closes it opens *La*, and starting switch *K* drops out, leaving the motor connected to the line through switch *L*.

As the exciter comes up to speed its voltage builds up and the + and — terminals at the bottom of the control panel are made alive. A straight-line diagram of the exciter connection is at the top of Fig. 3. Resistance *EFR* is connected permanently in series with the exciter shunt field and is used, when the machine is first started, to adjust its voltage.

Shunt-Field Circuit

The elevator-motor shunt-field circuit is the first to be made alive, as the exciter builds up voltage. This circuit and some of the auxiliary circuits affected by it are shown in Fig. 3. Starting at the + terminal of the exciter, the elevator-motor field circuit is through fuse No. 1, the potential-switch blow-out coil to the right-hand top terminal on the double-pole knife switch. Thus far the circuit is the same as that for the potential switch, described on page 423, August *Power*.

From the knife switch the circuit continues through the elevator-motor field-coil windings and resistance *PFR*. This resistance in parallel with the field coils accomplishes two purposes. It prevents a high voltage being induced in the field coils should the circuit be opened accidentally. Smoother speed changes of the elevator motor are also obtained when resistance is being cut in or out of its field circuit.

After passing through the motor field windings, the

circuit is to contact *La'* on the running switch. Until the running switch closes, contact *La'* is closed and, as can be seen, short-circuits coil *X* of the minimum-current shunt-field relay. Consequently, this relay cannot close until the running switch has closed and opened contact *La'*. The contacts of relay *X* are in series with the potential-switch coil and this switch cannot close until the motor-generator motor has been connected to full line voltage.

Assume that the motor-generator is up to full speed, then contact *La'* is open and the elevator-motor field circuit will be through coil *X*, field resistance *SR*, contact *Ga* on accelerating switch *G*, fuse No. 2 and to the — side of the exciter. Energizing this circuit closes relay *X* contacts, allowing the potential switch to close and make the controller alive so that the elevator motor may be started from the car switch.

Speed Control

Several other features of the control are tied into the elevator-motor field circuit and should be explained. These have to do with the speed control of the elevator. Speed-control relay coil *Z* is connected from contact *La'* to the bottom of fuse No. 4. This is equivalent to connecting this coil directly across the terminals of resistances *SR* and *SFR*. Closing and opening of relay *Z* will depend upon the voltage drop across these resistances.

Right-hand top contact *Ha* on accelerating switch *H* connects to resistance *SR* as shown. When the elevator is stopped this contact opens. On accelerating switch *G*, the bottom contact *Ga* connects to resistance *SFR*. This contact is closed when the elevator is stopped and the voltage drop across resistance *SR* is sufficient to close relay *Z*. When closed, the contacts of this relay short-circuit, through accelerating switch *G*, section 4-5 of the generator field rheostat, Fig. 2.

When the car switch is moved to either run position, contactor auxiliary field switch *H* closes and short-circuits resistance *SR*. This reduces the voltage to practically zero across *Z* coil and this relay drop opens and puts section 4-5 for the generator field rheostat into circuit. This operation cuts all resistance out of the motor-field circuit at starting and puts all resistance in the generator field to give a smooth start.

Speed Regulation

When *G*, the last accelerating switch to close, pulls in, its bottom contact *Ga* opens and connects resistance *SFR* in the elevator-motor field circuit to weaken the motor field and increases the motor's speed. Volts drop across resistance *SFR* is sufficient to close relay *Z* and its contacts short-circuit section 4-5 of the generator field rheostat, through top contacts of switch *G*, and brings the elevator to full speed. When stopping the elevator and contact *G* drops out, relay *Z* opens, but it closes again when the auxiliary field switch opens its contacts *Ha*.

Relay *Z* also performs the function of a speed-regulating relay in connection with the governor. The normally open contact on the governor is connected from the movable left-hand contact *Ha* on auxiliary field switch *H* to *KG* terminal at top of the control panel through the normally open contact on the governor and returns to —1 terminal on the control, the left-hand contact on the potential switch, bottom of fuses Nos. 4 and 2, Fig. 3. This connects the governor normally open contact across resistances *SR* and *SFR*.

If the car overspeeds, the governor contacts close and short-circuit resistance *SFR* out of the elevator-motor field circuit to increase the field strength and reduce the motor's speed. Coil *Z* is also short-circuited, and this relay opens its contacts *Za*, Fig. 2, and connects field-rheostat section 4-5 into the generator-field circuit, reducing the voltage of the generator to help slow down the elevator motor.

When the operations described in this article combined with closing the potential switch explained in August number, are completed, the elevator may be started from the car switch.

Fig. 1—Simplified diagram of motor-generator motor connections and its starting circuit

Fig. 2—Simplified diagram of speed-regulating-relay contact *Za* circuit

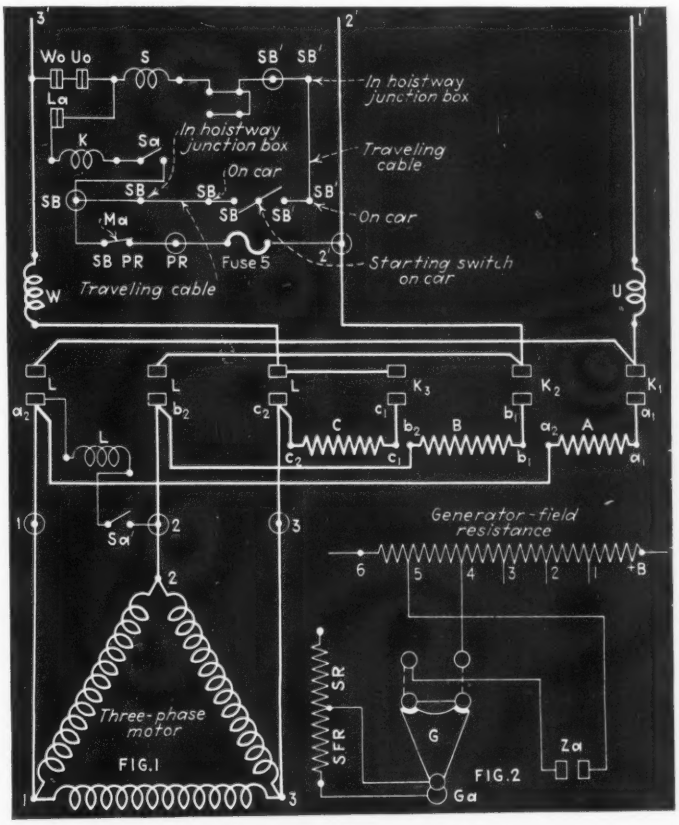
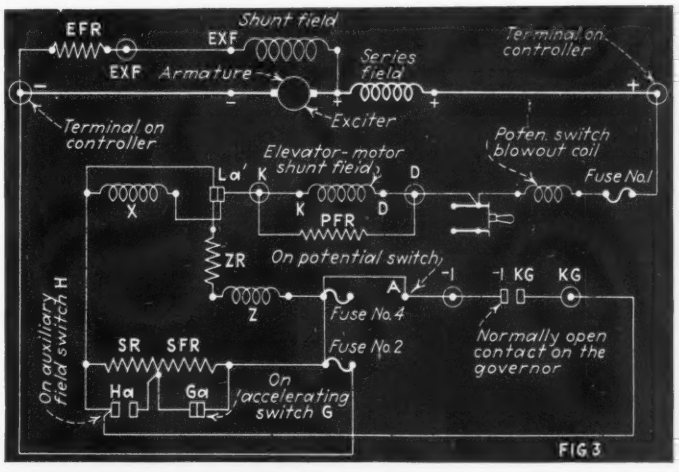


Fig. 3—Elevator-motor field and the exciter circuits



ONE BOILER REPLACES THREE

By E. H. Cook, J. J. Monaghan and C. L. Tutt, Jr.

Engineering Staff, Broadmoor Hotel

A single gas-fired unit with automatic combustion control has replaced three lignite-fired boilers at Broadmoor Hotel, Colorado Springs, Colo. Two old boilers do emergency service

TO PREPARE against approaching obsolescence of its boilers and assure economical steam generation for the future, the engineers for the Broadmoor Hotel, Inc., Colorado Springs, Colo., made a thorough survey of the existing equipment. This indicated the need of a single steam generator to replace three old chain-grate stoker-fired, 2,650-sq.ft. boilers then in use burning lignite. The new unit was to have sufficient capacity to generate economically sufficient steam to meet the seasonal demand, which varies from 6,000 to 25,000 lb. per hr. We decided to remove one of the old boilers, replacing it with a single unit capable of carrying the entire load, the two remaining old units being maintained as standby.

Two fuels were available for steam generation: natural gas from the Amarillo, Texas, field and lignite coal from local mines. Both were considered. Natural gas we finally selected for the reason that it is available in unlimited quantities on a long-term, price-protected contract. It was decided, however, to design the boiler furnace so that it can be readily changed over to burn pulverized coal.

Specifications covering a steam generator with full-automatic combustion control were drawn up and submitted to various manufacturers. These stipulated that the boiler must be capable of operating efficiently at loads from 6,000 to 25,000 lb. per hr. at 150 lb. gage on the station side of the stop valve with a minimum of 100 deg. F. superheat. The specifications also stipulated a control capable of maintaining steam pressure and CO_2 constant within close limits over this wide range, the control also being required to close an emergency fuel valve automatically in case of failure of fuel supply, forced-draft air supply, induced draft, or electric current to the control.

The steam generator selected is a fusion-welded 3-drum type having 342 3¼-in. seamless drawn-steel tubes. A convection-type superheater is installed above the lower tube bank. To secure a minimum superheat of 100 deg. as required in the specifications, and eliminate excessive superheat at higher loads, an automatic thermostatically controlled desuperheater is provided to control steam temperature at higher ratings.

A furnace is provided approximately 11 ft. wide and 14 ft. 3 in. deep, with an average height from furnace floor to lower tubes of 15 ft. The furnace walls are independent of each other, there being a 1¼-in. expansion joint in each corner to allow for free movement. Sidewalls are supported by two rows of bonding tile anchored to the backstays. Front and rear walls each have one row of bonding tile similarly anchored. The furnace floor is ventilated and is not anchored to the sidewalls, but has a 1-in. expansion joint on all sides.

Three combination forced-draft gas and oil burners are installed in the front furnace wall and are enclosed in a forced-draft windbox. Air under pressure is delivered to the windbox through an underfloor duct from a motor-driven forced-draft fan. Natural gas is piped to the plant at an average pressure of 39 lb. gage and is metered at this pressure. A pilot-operated pressure regulator reduces this to approximately 6 lb., the maximum pressure used at the burners.

Provision for standby service, in case of failure of gas supply, is taken care of by an 11,000-gal. oil-storage tank, buried outside the power plant. Fuel oil, of 28 to 36 gravity, is piped to a triplex pump, which delivers it to the burners at 75 lb. pressure. This oil is burned in the combination gas and oil burner with steam atomization.

Direct current is generated at the plant, and as the

PRINCIPAL NEW POWER EQUIPMENT

Broadmoor Hotel, Colorado Springs, Colo.

Boiler	Babcock & Wilcox Co.
Heating surface, sq.ft., 4,044; maximum steaming capacity, 25,000 lb. per hr.; gage pressure, lb. per sq.in., 150; total steam temperature, deg. F., 463; furnace volume, cu.ft. 2,358; maximum B.t.u. liberated per cu.ft. per hr., 15,400	
Superheater, heating surface, 925 sq.ft.	Babcock & Wilcox Co.
Breeching and dampers	Babcock & Wilcox Co.
Baffle tile	Babcock & Wilcox Co.
Boiler setting	Babcock & Wilcox Co.
Steel casing	Babcock & Wilcox Co.
Gas and oil burners	Babcock & Wilcox Co.
Desuperheaters	Babcock & Wilcox Co.
Refractories	Denver Fire Clay Co.
Automatic combustion control	Denver Fire Clay Co.
Gas-burner safety system	Denver Fire Clay Co.
Boiler meter board	Denver Fire Clay Co.
Gas-pressure regulator	Fisher Governor Co.
Gas-control valve	Denver Fire Clay Co.
Feedwater regulator	Bailey Meter Co.
Steam-flow meter	Bailey Meter Co.
Draft gages	Ellison Draft Gage Co.
Indicating gas-pressure gage	Ellison Draft Gage Co.
Safety valves	Consolidated Ashcroft-Hancock Co.
High-pressure valves	Edward Valve & Mfg. Co.
High-pressure valves	Consolidated Ashcroft-Hancock Co.
Blowoff valves	Garrett Machine Co.
Non-return valve	Elliott Co.
Water column	Diamond Power Specialty Corp.
Emergency gas-tripping valve	Denver Fire Clay Co.
Forced-draft fan	Clarage Fan Co.
Fan coupling (Fast)	Bartlett Hayward Co.
Feedwater treatment	Dearborn Chemical Co.
Indicating gas-flow indicator	Meriam Co.
Gas meters (displacement)	Pittsburgh Meter Co.
Fuel-oil triplex pump (V-belt driven)	Worthington Pump & Mach. Corp.
Piping	Stearns Rogers Co.
Pipe covering (Eagle No. 66)	Joy & Cox Inc.
Fan motor	Reliance Elec. & Eng. Co.
Fuel-pump motor	General Electric Co.
Inverted rotary converter	General Electric Co.
Gas-valve control motor	Denver Fire Clay Co.
Oil-storage tank, 11,000 gal.	Eaton Metal Products Co.

combustion control operates on alternating current, an inverted rotary converter was installed to supply power to the combustion control. A throw-over switch is provided for emergency service on city utility power.

The automatic combustion control selected comprises a control cabinet, a motorized gas valve, two motorized damper-operating mechanisms, one for the forced-draft damper and one for the induced-draft damper, and an electrically operated emergency stop valve. This fully proportioning control automatically maintains correct relation between fuel input and steam output, and between fuel input and combustion-air input. The control cabinet contains three control units and a switch case, as shown in the boiler room photograph. The upper unit is the steam-pressure control unit; the next lower the forced-draft control unit; the third from the top the induced-draft control unit. The steam-pressure control unit maintains steam pressure constant by operating the motorized gas valve proportioning fuel input to the steam demand. Correct relationship between fuel and air input is maintained by the forced-draft control unit by operating the motorized forced-draft damper. The induced-draft control unit maintains correct furnace pressure by operating the motorized induced-draft damper.

A thermal overload line switch and a 4-position selector switch is contained in the switch case, the positions being Off, Manual, Semi-Automatic and Automatic. When this switch is in the Off position, no control circuit is energized. When in the Manual position, the circuits controlled by the control units are not energized, but the motorized gas valve and the motorized dampers may be operated by manually closing momentary contact switches mounted on the door of each control unit. When the selector switch is rotated to the Semi-automatic position, the circuits controlled by the forced-draft control unit and the induced-draft control unit are energized. If, with the selector switch in this position, the fuel input is increased or decreased by means of the manual control switch, the control will automatically adjust the air and furnace pressure. Rotating the selector switch to the automatic position energizes the circuits controlled by all control units, and operation of the boiler is entirely automatic.

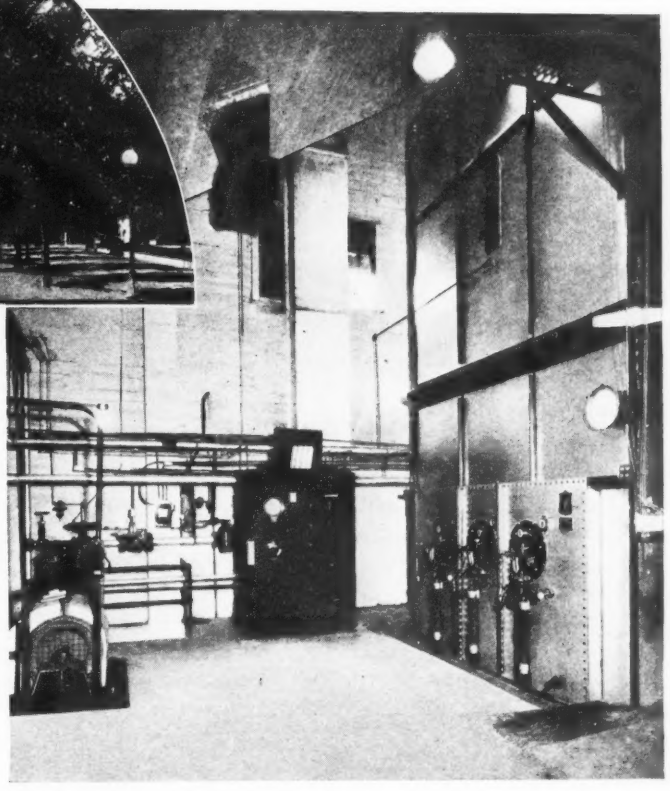
The emergency stop-valve system is a safety feature, its purpose being to minimize the possibility of explosions which might result from a failure in any of the boiler units or in the current supply to the instrument. This emergency stop valve will instantly close should fuel supply, forced draft, induced draft, or electric current fail. It will also close if the proper relations between fuel and air input become unbalanced beyond a predetermined limit. After being automatically tripped, the emergency stop valve must be manually reset before operations can be resumed.

On completion of the installation, tests were conducted by engineers from the Broadmoor Hotel, Babcock & Wilcox, and Denver Fire Clay Co. These tests were conducted at various loads ranging from 75 to 200% of rated boiler capacity. The average over-all efficiency was 79%. Both the boiler and automatic combustion control met the manufacturer's guarantees. The automatic combustion control makes possible obtaining day-in and day-out over-all efficiencies equivalent to those usually obtained only under test conditions.

Because of the age of the old equipment, it was necessary to replace it, therefore this was the primary purpose of making the change. When the new job was being engineered, careful consideration was given to the economics of the problem. Estimates indicated that reduced operating costs with the new unit would repay its investment in approximately six years. Operation to date indicates that the original estimates were conservative.

Broadmoor Hotel, Colorado Springs, Colo.

New boiler has 25,000-lb. per hr. maximum steaming capacity and is fired by three combination gas and oil burners



COOLING FOR COMFORT

Refrigeration for air conditioning is as vital as heating. This, the ninth article in the series, shows what takes the heat away

By R. B. Purdy
Associate Editor

TO MAINTAIN a constant temperature in a building during cold weather, a heating system must supply heat at the same rate that it is being lost from the building, and to raise room temperature, heat must be furnished at a rate greater than the rate of heat loss. Similarly, the cooling plant of an air-conditioning system must be capable of removing heat at the rate it is absorbed by the space to be conditioned.

Sources of Heat

In most cases, the heat which the refrigerating plant must absorb comes from five sources, (1) heat transferred through the building walls because of the difference between inside and outside temperature, (2) heat brought in with outside air, (3) heat emitted by persons, electric lights, motors, etc., (4) heat in water vapor removed by dehumidification, (5) radiant heat from sun through windows. It is not the intention to show here how to calculate the refrigeration load, but to discuss the refrigerating plant. Heat transferred through building walls and air infiltration is calculated in the same manner as for heating systems. Heat removed by dehumidifying was covered in the *February* number of *Power,* page 76. The effect of sunshine on the required refrigeration capacity has been investigated by the A.S.H.V.E. and results reported in their *Transactions,* but there is still much data needed before the effect of sun's radiation can be accurately taken into account.

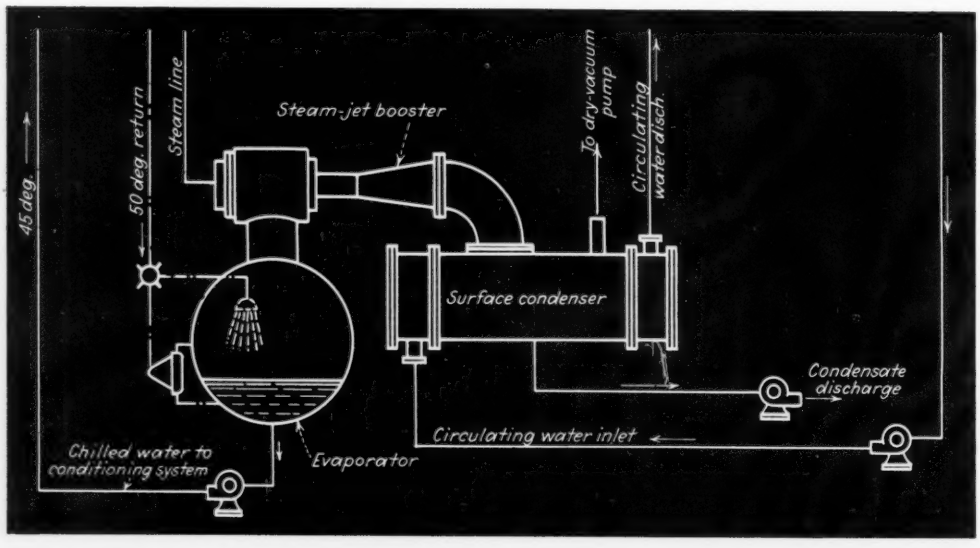
Occasionally cold water is available from a well or other source in sufficient quantity to meet the cooling requirements of air conditioning, but in most cases it is necessary to install mechanical refrigeration to provide the cooling medium. Under certain conditions, ice has been purchased and used as the cooling medium. When the cooling load is not too large and the air-conditioning plant is operated relatively few hours a season, as in a church, the use of ice may prove economical as the fixed charges on the investment in a refrigerating plant are avoided.

Mechanical refrigeration for air conditioning must meet conditions quite different from those usually encountered in plants serving industrial purposes. Low temperatures are not involved, since for comfort conditioning the temperatures of the cooling water in the washer or surface convector are seldom reduced below 45 to 50 deg. Usually condenser cooling water is expensive, space for the plant is restricted, noise is objectionable to building occupants, and most important is the wide fluctuations in the cooling load that must be served.

Maximum demand on the refrigerating system usually occurs for short periods, and the system will operate most of the time with a load of not over 60% of maximum. It should be designed so that it will operate economically at average loads and still be able to carry the maximum load as an overload.

As load drops, efficiency of refrigeration decreases rapidly unless provision is made to take care of such fluctuation. The decrease in efficiency is concentrated in the compressor since condenser and evaporator can be designed for maximum load without much loss of efficiency at low loads.

As the heat to be removed decreases, the weight of refrigerant exaporated decreases, and if suction conditions are not changed the volume of refrigerant vapor that must be handled by the compressor also decreases. Unless something is done to decrease the displacement capacity of the compressor it will lower the suction pressure, thus increasing the specific volume of the vapor until the capacity of the compressor is reached.



Steam-Jet System

Water to be cooled is sprayed into the evaporator where it boils at the high vacuum corresponding to the temperature to which it is to be cooled. A steam jet maintains the high vacuum and compresses the vapor from the boiling water to the pressure maintained in the condenser. Condenser provides a vacuum into which the steam jet exhausts, so reducing the extent to which it must compress the vapor and condenses the steam and vapor. Dry vacuum pump removes air from the condenser

This results in a lowered temperature in the evaporator, which may be enough to freeze the cooling water. In addition, power consumption of the compressor remains practically the same as at the full load.

How to Reduce Capacity

There are several ways to reduce the capacity of the compressor and so effect a decrease in power consumption as refrigerating load drops. When the compressor is driven by a steam engine or D.C. motor, speed control makes an effective and efficient way to decrease compressor capacity. With A.C. motor drive, speed control is expensive and involves a decrease in power factor and motor efficiency. With constant-speed operation of the compressor, clearance pockets in the compressor provide an efficient method of load control. Frequent starting and stopping of reciprocating compressors to meet load variation is not considered good practice, as it tends to cause mechanical troubles. Load fluctuation can also be taken care of by installing a number of smaller compressors and decreasing the number in operation as the load diminishes. But small units are more expensive than large, and a certain amount of necessary duplication of equipment makes this method of control high in first cost.

With centrifugal compressors, the quantity of cooling water may be decreased as the load decreases, causing condensing temperatures and pressures to rise. The centrifugal compressor acts very much like a centrifugal pump, for as the discharge pressure is increased at constant compressor speed its capacity and power input both decrease. There is some loss of efficiency, however, as power input does not decrease as fast as refrigeration capacity.

Six Refrigerants

The six refrigerants in general use for air conditioning are: ammonia, carbon dioxide, dichlorodifluromethane, methyl chloride, dichloromethane, and water. Reciprocating compressors are used with the first four because of the high pressures involved. Carbon dioxide involves higher pressures than any of the other refrigerants, and some efficiency is lost when the condensing-water temperature is high, but it is nevertheless used to considerable extent in public buildings because of its non-toxic character. Dichlorodifluoromethane (Freon) is becoming more popular as a refrigerant for air conditioning. Under normal conditions it is non-toxic non-irritant and non-explosive, but in contact with flame it may break down to several toxic components. It has lower latent heat than the other refrigerants, consequently a greater weight must be circulated per minute per ton of refrigeration. But its specific volume is low, and theoretical displacement of a compressor is thus only about 1.7 times as great as for ammonia, which is probably the most-used refrigerant in large installations where its pungent odor is not an objectionable characteristic. It has higher heat content than any of the refrigerants except water.

Dichloromethane operates at pressures below atmosphere and is used only with a centrifugal compressor. Methyl chloride is used mostly in small capacity units.

Water as A Refrigerant

The relatively high temperatures of air conditioning make it possible to use water as a refrigerant. It is used either with a centrifugal compressor or steam jet, both being used as boosters to produce the extremely high vacuum necessary to make water boil at temperatures of 40 to 50 deg. With this system, heat exchangers such as water coolers are unnecessary as the water from the washer or surface cooler is cooled directly in the evaporator into which it is sprayed. The temperature of this return water is higher than the temperature corresponding to the vacuum maintained in the evaporator, consequently a portion of the return water flashes in to steam, the latent heat for this evaporation being absorbed from the incoming water, thus cooling it. The vapor product is compressed either by a steam-jet or centrifugal compressor to the vacuum carried in a condenser.

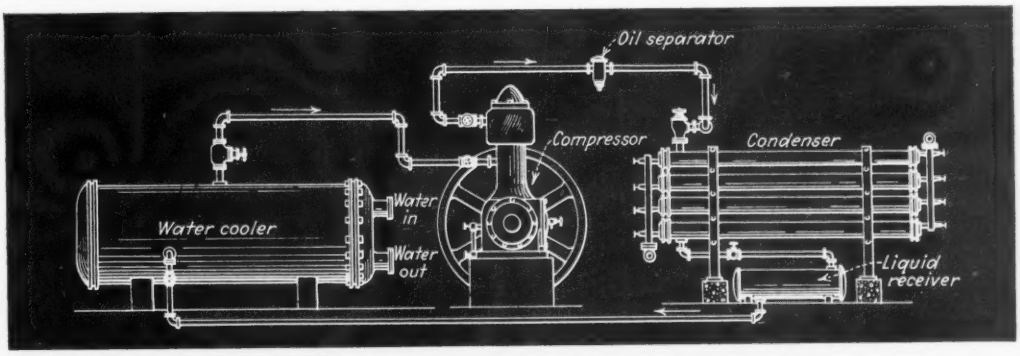
A main advantage of this type of refrigeration is that dangerous or costly refrigerant are not required. When steam jets are used, the only moving parts are centrifugal pumps. The quantity of cooling water required, however, is about three times as much as for other types of refrigerating systems. When a centrifugal compressor is used, cooling water requirements are greatly decreased. Likewise power consumption automatically varies nearly in proportion to the load.

The ammonia absorption system of refrigeration is not used in air conditioning as it is adapted primarily for use when relatively low temperatures are required.

Today many controls have been adapted for use on refrigeration plants so that their operation can be made very nearly automatic. In air conditioning this is particularly desirable but controls must also be arranged to operate in conjunction with other controls on the air conditioning system. A later article will cover this subject. The next article in this series will deal with methods of distributing air throughout the space to be conditioned.

Ammonia or Freon System

Liquid refrigerant enters the cooler through an expansion or float valve. In the cooler, heat from the water causes the refrigerant to boil. Vapor from the boiling refrigerant is removed by the compressor and pressure raised to that required for its condensation in the condenser at the temperature of the available cooling water. From the condenser, liquid refrigerant collects in the receiver



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INTERNAL-COMBUSTION TURBINE

By William E. Trumpler

Mechanical Engineer, Easton, Pa.

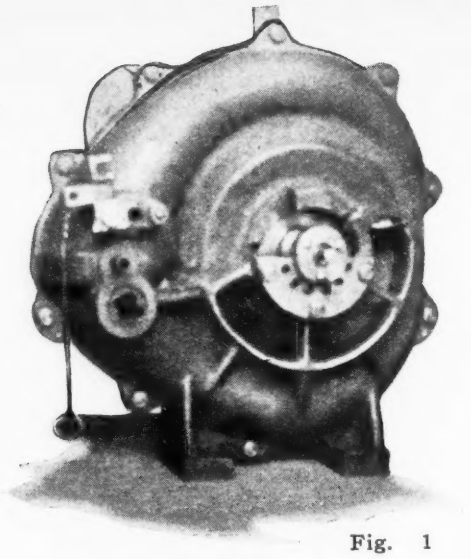

Fig. 1

HERE is an interesting solution of the much-discussed internal-combustion turbine, a single-wheel type using a principle not generally known. Fig. 1 shows a small experimental machine which has operated successfully, proving the usefulness of the principle which the author conceived over ten years ago.

The turbine is essentially a continuous-cycle, constant-pressure type (See *Power*, Feb., 1935, page 78), wherein compression and expansion are performed by a single wheel. To understand operation more clearly (patent applied for) see Figs. 2 and 3. In Fig. 2 is the usual constant-pressure cycle. At left is the centrifugal compressor, discharging air into the burner, from which the heated gases expand through the turbine at the right. The turbine wheel is coupled to the compressor. The succeeding step is made clearer by showing the compressor volute surrounding only half of the periphery of the impeller, leaving the other half inactive. Ordinarily such an arrangement is undesirable; however, in this case the feasibility of partial application in a centrifugal compressor is shown. The same reasoning has been applied to the turbine. Blading in turbine and compressor wheels is quite similar, the only difference being the axial intake edge, which is bent forward for the compressor to take in air, and backward for the turbine to provide reaction. It is easily possible to design a wheel with axial openings on both sides, one for compression, the other for expansion.

If we insert the active turbine segment into the inactive compressor half, we arrive at the arrangement in Fig. 3. A single wheel, with approximately radial blades, is working at opposite sides of the casing circumference as compressor and turbine. Each blade travels with every revolution through the cool compressor section and the hot turbine part. Heating and cooling follow in such rapid succession that the blade material assumes an average temperature. The burner and the seal at the opposite side occupy only a small fraction of the periphery, which of necessity is inactive. By careful design, the hot turbine casing half can be separated sufficiently from the cool compressor segment to keep heat flow small, and no water cooling is required. In Fig. 1, the burner is at the left, and bearings are mounted on the bottom half, which is the compressor segment. The air intake is on the front side, while the exhaust, with its conical draft tube, is on the back. At the burner the ignition opening, gas connection and a tube for pressure measurement are visible.

The model shown is essentially the same as a machine built in 1922. Mechanical construction has been simplified, so that experiments can be carried out more advantageously and at minimum expense. The greatest departure from the original is probably the change in the burner from gasoline to city gas as fuel. This, however, brought about a limitation of the running speed to 4,500 r.p.m., without boosting the gas pressure above the 10-in. water at which it is supplied. Even at this low speed, where thermal efficiency is less than 1%, hydraulic performance is satisfactory (see note). With increasing speed, the thermal efficiency increases more rapidly than the square of the speed. At 15,000 revolutions, thermal efficiency would be over 10%.

The model turbine, as it is, represents one of the simplest prime movers in existence. Even though its fuel economy will be less than that of reciprocating combustion motors, its low first cost, simplicity and reliability are expected to make it ideal for reserve power.

Note: During all test runs with full flame temperature, the rotor blades retained their original gloss (no discoloration) while the cast iron casing come to a low red heat.

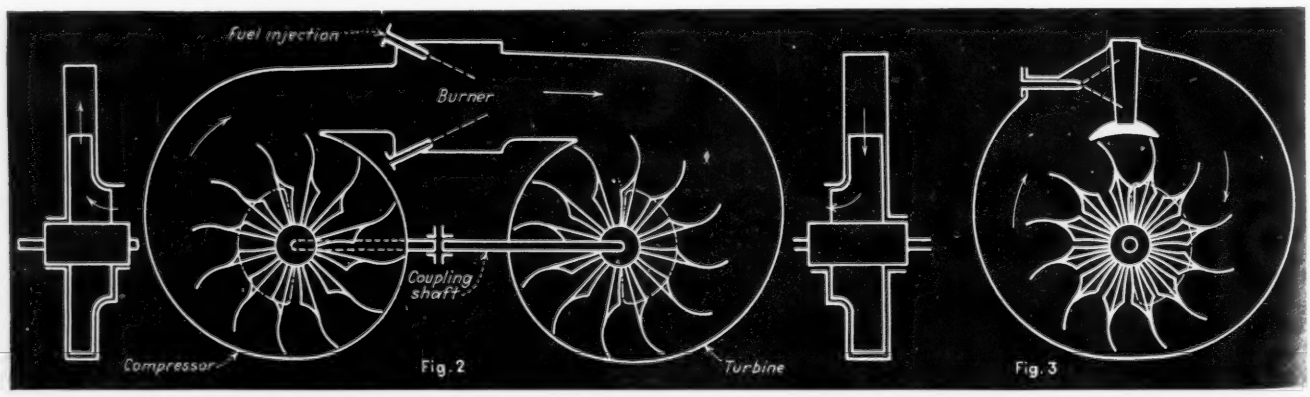

Fig. 2—Principle of the turbine design

Fig. 3—Cross-section of single-wheel unit

DON'T THROW AWAY USED REFRACTORIES

By C. C. Hermann
Waterloo, Iowa

MANY power engineers throw away better refractory than they can purchase when they throw away old broken firebrick. Repair of a boiler refractory wall always involves throwing considerable brick into the refuse pile. Partly eroded brick in burnt-out spots must be removed, and after the glaze has been chipped off it is found that many brick around the burnt spot are cracked due to temperature changes in the furnace from time to time. These broken brick come down with the burnt lining, and their salvage as brick is next to impossible as well as prohibitive due to the labor cost of cleaning them.

Old brick are practically neutral to the furnace temperatures in which they have been used. All shrink has been eliminated and all impurities burnt out.

New firebrick of good grade cost about 7 cents each, and the higher grades of refractory such as Carborundum cost $1 each brick of standard shape. It is apparent, therefore, that the repair of a refractory wall is an item of considerable expense. Usually the brick must be removed when approximately 50% eroded, so that the actual value obtained from the brick is about 50 cents on the dollar spent. This percentage can be raised to at least 80 cents out of each dollar of first cost for refractory by crushing the old brick and returning the crushed material into use.

Use for Patch

Although not new, use of crushed firebrick in producing a refractory patch is not generally and thoroughly understood. A method I have used with considerable satisfaction may help others to reduce the expense of maintaining their boiler refractory walls.

Crushing of the brick, one of the more important phases of the work, is a baffling job to many. The simplest and most expensive way is with a mallet. Cost per 100 lb. of brick crushed in this way is 50 cents approximately. If, however, a crusher of the jaw, roller or hammer type is available, the brick can be crushed for about 20 cents per 100 lb. Brick must be crushed so that it will pass a $\frac{1}{4}$-in. mesh screen.

Cement used for making the batter is the next important consideration. It does not pay to purchase a cheap low-fusion-point cement. Remember that the wall, whether it be built of whole brick or crushed brick, is not better than the grade of cement used in the mixture. If a poor cement is used, the wall will fail because the cement burns out, thereby exposing each edge of the brick to high temperature on both faces at the joint, thus increasing erosion. Obviously when the brick corners are subjected to heat on two sides, they fuse rapidly. By the same reasoning, the crushed particles of brick imbedded in the cement are exposed to the high temperature of the furnace on all sides as soon as the cement burns out, and there is no way to dissipate the heat from the particles. Consequently, the particles melt and the patch fails.

The amount of cement used, assuming it is a good grade of high-temperature cement, is 1 lb. of cement to 2 lb. of firebrick. I have experimented with different mixtures, and this gives most satisfactory results.

Having measured out the cement and crushed brick for the patch, bearing in mind that a cubic foot of this material weighs 120 lb., we are ready to proceed with a mix. Where a crusher and mixer is at hand, this work is very cheaply performed. In the larger plant such machinery is a paying proposition. The crusher need not have over $1\frac{1}{2}$ tons per hour capacity, and a 1-cu.ft. mixer usually is large enough.

May Use Mortar Box

Where a mixer is not available, the ordinary mortar box may be used. The cement and water are thoroughly mixed first. This mixture should have the consistency of pancake batter or thick cream.

Having produced the proper consistency of batter, add the ground refractory slowly mixing thoroughly with a hoe. See that chunks of refractory are broken down and mixed until the particles are well covered with cement. The finished batter must have a consistency of thick clay so it can be rolled into a ball.

We are now ready to put the refractory into place in the furnace wall. Obviously the patch, so far as the wall is concerned, has been prepared beforehand. The old brick have been removed down to the backing brick unless the burnt-out portion is deep enough so that a good thick patch can be placed. In the latter case, the edges of the burn are trimmed out and the glaze is removed with a chisel. The surface is made slightly rough. Be sure all fine dust is removed, after which the surface is given a wash with pure cement mixed thin enough to paint on the surface.

After the surface is painted with cement, the refractory batter is put in place. A wood mallet is required to pound the batter into place until all air bubbles have been eliminated. If there are voids in the patch, its life will be materially reduced.

Curing the patch is another phase of the work rarely given the necessary attention. A slow wood fire should be built under the patch and maintained for at least 8 hr., after which the temperature may be increased gradually for the next 24 hours. At the end of this time the patch should be ready for service at high temperatures. Time given here is for a good-sized patch.

TEST YOUR OWN BOILERS—V

By Walter H. Wood
Combustion Engineering Co., Inc.

In this fifth article of the series, Mr. Wood discusses equipment and methods for collecting general data

IF A test shows low efficiency, or the desired rating is not obtained, find the reason. If test results are good, the records will aid operators to approach test results in regular operation. For these reasons, keep a general log of pressures, drafts, temperatures, gas analyses and such other data as may be of help. Include these records:

Pressure and Drafts.
- Steam pressure in boiler, at superheater outlet.
- Air pressure at fan or in duct, under grate or in each stoker compartment.
- Draft in furnace, inside boiler damper, inside air-heater outlet.

Temperatures
- Water entering boiler and economizer.
- Air entering furnace, air heater.
- Air leaving air heater.
- Gases leaving boiler, economizer and air heater.
- Steam leaving superheater.

Analyses of Gas
- CO_2, CO and O_2 in gas leaving boiler.
- CO_2, CO and O_2 in gas leaving economizer or air heater.

Record height of water in the gage glass at the beginning and end of the test and hourly during the test.

Average pressure at which steam is generated must be known to calculate output. If a superheater is included, pressure at the superheater outlet is required. Steam pressures in boiler and at the superheater outlet show steam-pressure drop through the superheater.

Calibrate your steam gages before a test with a deadweight tester, not with a "standard" gage. If there is a head of water on the steam gage, calculate the effect of this head and set the needle to correct for it, or correct the readings after the test. In making this calibration, note the approximate temperature of the pipe leading to the steam gage. Assuming it to be about 60 deg., and head on the gage to be 9 ft. 6 in., the correction for head is made thus: 1 cu.ft. of water at 60 deg. F. weighs 62.37 lb., and pressure per sq.in. of a column 1 ft. high is therefore $\frac{62.37}{144} = 0.433$ lb. A head of 9 ft. 6 in. is equivalent to 9.5 x 0.433 = 4.11 lb., the amount by which the gage readings must be reduced to correct for the head.

Furnace and boiler outlet drafts are usually low enough so that inclined gages can be used, which permit greater accuracy of observation. Ordinary U gages are generally satisfactory for measuring all air pressures. Use a U gage with legs close together for ease and accuracy of reading, and with a scale graduated to read in 1/10 in. with zero at the middle of the scale. Be careful to see that all gages are properly set up. Level inclined gages carefully, and be sure legs of U gages are vertical. Be sure that piping and tube connections to gages have no leaks.

Correctness of pressure and draft readings depends largely on the location of the piping in ducts and flues. Do not point the pipe in the direction of, or against, the flow of gas or air, or the reading will be seriously affected by the velocity of the gas or air. Unless you have specially designed draft tips, use a pipe with the end cut off square, placed in the gas or air stream squarely at right angles to the direction of flow. If measurements are made in a steel flue or duct, drill and tap the steel plate and screw the draft pipe in until it is just flush with the inside face of the duct, then fasten it securely with a locknut. If draft measurements are made through a brick setting be sure the pipe is at right angles to the direction of gas flow and away from boiler tubes, damper, or anything else which will cause eddies in the gas stream.

The difference between furnace and boiler outlet draft measurements indicates draft loss or drop through the boiler. If baffles are properly designed and installed and are tight, there is a fairly definite draft loss corresponding to each rating when fuel is properly burned. A decrease in draft loss combined with an increase in gas temperature leaving the boiler indicates a leak in the baffling. A decrease in draft loss without a decrease in gas temperature leaving the boiler indicates a restriction in the gas passages, possibly a slag accumulation on the tubes. An increase in draft loss combined with an increase in gas temperature leaving the boiler indicates too much air is being used to burn the fuel (A furnace draft gage alone is a fairly good guide for an operator). A material drop in furnace draft may indicate a hole in the fuel bed or else insufficient draft for burning the fuel. Considerable increase in furnace draft may be due to too heavy or too compact a fuel bed, or to too much damper opening.

Water Temperature

You'll need a record of water temperature entering the boiler or economizer to calculate output. Use a reliable thermometer to measure feedwater temperature. Usually air temperatures can be taken with thermometers, except for air leaving the preheater, where some other method may be preferable. The most satisfactory instrument for measuring temperatures of preheated air

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and boiler and preheater gases is a potentiometer and iron-constantan thermocouples. The hot junction of the couple should be butt-welded with a weld not materially larger than wire diameter, and lead wires of the same material as the couples carried to a potentiometer in one central location, where all temperature measurements are made. Base-metal pyrometers are usually not very suitable for making these measurements; carefully calibrated mercury pyrometers are generally satisfactory under ordinary conditions.

Temperatures of gas and air entering and leaving a preheater are necessary to calculate preheater performance. Temperatures of air entering the furnace and of gas leaving the boiler, economizer or preheater are necessary in calculating heat balance.

If a superheater is used, you must know outlet steam temperature to calculate output of the unit. A thermometer well is usually provided.

A succeeding article will show what part the foregoing temperature measurements play in calculating losses which go to make up the heat balance.

Analyze flue gas leaving the boiler, economizer or air heater at regular intervals during the test—an analysis of CO_2, O_2 and CO every 15 min. can be made easily with one Orsat. These are needed in calculating heat balance. If you have a second Orsat, use it frequently to analyze for CO_2 only—the operator can use these analyses in maintaining good combustion conditions. Many plants have CO_2 recorders or steam-flow air-flow meters which replace the second Orsat.

An iron pipe is all right for collecting gas samples, providing it isn't in too hot a gas stream. If gas temperature is much above 1,000 deg., the sample will not be reliable. Put the gas-sampling pipe at about the same place as the pyrometer or thermocouple used for measuring gas temperatures.

MAINTAINING STEAM TRAPS

DRAINAGE of condensate from the steam distribution systems serving large industrial or institutional groups of buildings requires the continuous and proper operation of a large number of traps. Hence maintenance of such traps is an important function of the plant engineer. In a recent interview with the engineer in charge of an extensive heating system serving a large group of buildings, the following trap maintenance experience was obtained.

The distribution system operates at an average pressure of about 125 lb. per sq.in. Traps on the distribution mains are in manholes and are connected to cast-iron drip boxes through a water seal. Two traps in parallel are used so that one trap will be available while the other is open for inspection. Other traps are in the buildings served and are not provided with bypass valves because if left open accidently they would remain open until the next inspection, during which interval steam would blow through to the sewer.

So called continuous-flow traps are used exclusively. These are ball-float traps adjusted to close when water level is about 1 in. above the discharge valve. Thus, when operating properly, the trap is never completely empty and steam will not blow through.

Traps at strategic points in the distribution system are inspected every night. All other traps are inspected once a week. Each trap is provided with a test valve in the discharge piping which the inspector opens to observe the discharge. With experience he is able to tell whether the trap is blowing through steam or discharging only condensate. In case there is no discharge, a valve connected to the top or side of the trap at the top may be opened to determine whether the trap is full of water, hence stuck closed.

When a trap is found to be operating incorrectly, the bonnet is removed and with it all of the trap working parts. This includes float, levers, valve pin and valve seat. A new or repaired assembly is installed and the defective trap mechanism brought to the shops for complete overhaul, repair and adjustment of point of closure.

Of the steam traps in service in February, 7.7% were repaired during the month. From this it might be inferred that a trap may be expected to remain in service without repair for about 13 months.

As might be expected, maintenance records show that valve leakage is the most frequent cause of trap trouble. A change in valve seat and plug material to heat-treated steel three years ago greatly decreased trouble from valve cutting. Valve leakage is now more often caused by rust preventing tight closing rather than cutting.

Sticking of the trap mechanism is the second most frequent cause of trap trouble. It is due in part to rusting of the fulcrum pins.

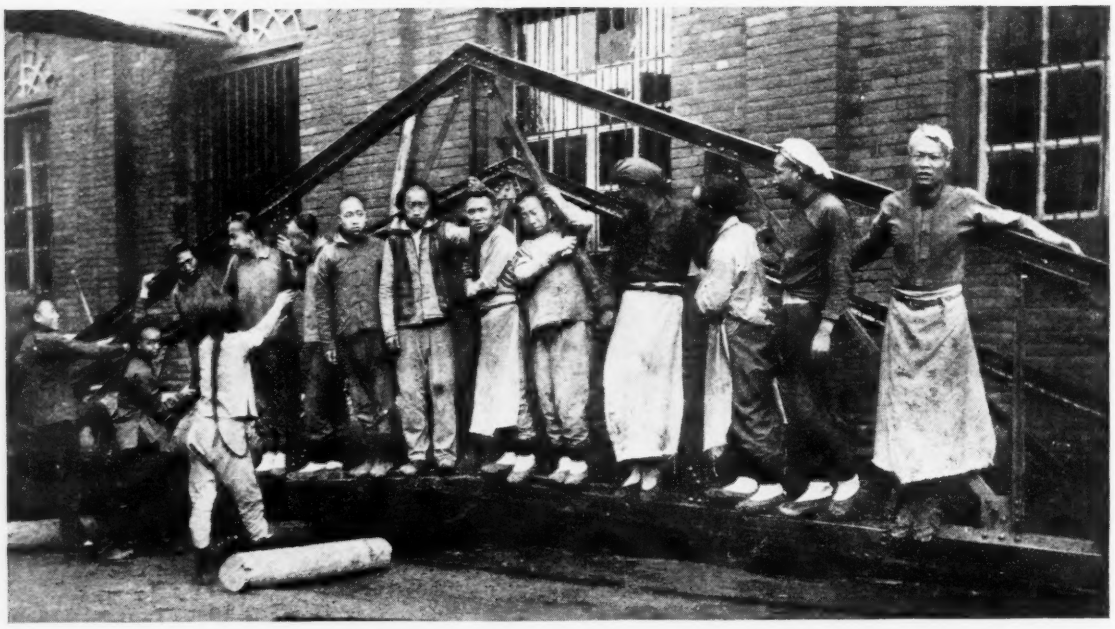
The third most frequent cause of trouble is leakage around the threads between the valve seat and trap bonnet. When this occurs, the bonnet is discarded, no attempt at repair being made.

Other trap troubles in order of their importance are play in trap mechanism, leaks at bonnet gasket, leaks through body of trap and at inlet and discharge pipe connections, leaks in float, bent lever arms.

Wear of the lever pins and bearings causes play to develop in the operating parts of the trap. As a result the water level at which the trap starts to discharge is higher and level at closing is lower. Likewise this play offsets the continuous flow principle of the trap as there is an interval during which the trap is closed.

When leaks occur in the trap body or at the inlet or discharge connections, no attempt is made to bronze-weld the cast iron or to make repairs, the body being discarded.

Float troubles occur very infrequently and are usually traceable to injuries received from handling during repair.



Truss-testing in Far Cathay, with 14 coolies and their pigtails making dead weight

IN FAR CATHAY

By N. L. Rea

Contract Service Department,
General Electric Company

NECESSITY may be the mother of invention as they say, but she is often the mother of accomplishment as well. When it's a case of "Die, dog, or eat the hatchet" it's a poor dog that won't risk a bite; a good dog may eat it clean and ask for more.

Years ago a customer in the Far East asked for a man to erect a generator and switchboard then on order. That looked like a simple job, but, knowing from experience that things were not always what they seemed, we picked a man of broad experience and intestinal fortitude. There were grounds for our suspicions.

The old equipment was overloaded, there was hardly room for the new engine and generator and there was load in sight for that and more, so they decided to build a new plant and elected our man as designing engineer, building engineer, operating engineer, etc.—in fact, "chief cook and bottle washer."

Good brick and masons being available, the type of building was determined automatically. The roof wasn't so simple. That was a land of heavy snows; room for future growth necessitated a large building; wooden roof trusses were out because of lack of suitable timber, cost, and the fire risk. The only steel available was 2x2-in. angles ordered originally for making poles, flat plate, and bar stock up to $1\frac{1}{4}$ in. in diameter. After careful study, four angles were put together with tie plates between to make something that looked like an "I" beam. With these "beams" as a starting point, a roof truss was designed and fabricated.

The first trusses looked all right, but there was the chance of a slip-up in design or calculation, and 'twas better to be safe than sorry. The first truss was, therefore, supported on blocks alongside the wall and given a test loading. The load was supplied by "weighing in" the required number of coolies and letting them stand in the truss. There were no signs of undue deflection or weakness, so fabrication proceeded. A new, larger and taller stack, a water storage tank, etc., were built. The new building was designed to use the old steam main and piping. Money was scarce and new pipes could not be obtained without a long delay.

Then, when the new generator and engine were in operation, the old equipment was moved. Opening of the new plant was celebrated by a collar of incandescent lights around the top of the stack, equipped with a home-made flasher made from wood and odd pieces of sheet copper.

This was a hot and dirty job and the erector needed the comfort and solace of hot baths in a regular tub. Bath tubs were unheard of, so again it was a case of do it yourself. Frames were made and a reinforced-concrete bath tub, the first regular full-length tub in the Province, poured. The tub was put in a bath-house built under the water storage tank.

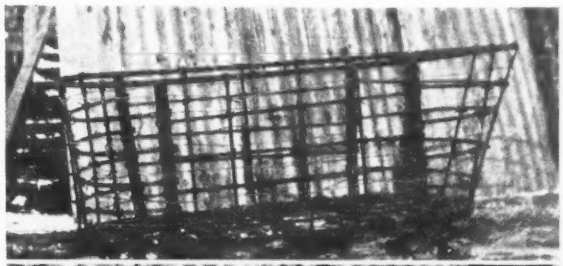
The aforesaid erector did such a bang-up good job on the new power house that the authorities decided

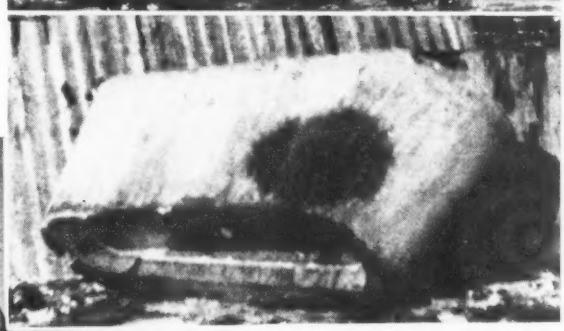
ey couldn't get along without him. They made a eal whereby he stayed with them for years. General anagers might come, collect their "squeeze," and lose heir jobs to the next high bidder, but the operating ngineer stayed on to keep the wheels turning. There ere occasional disorders and disturbances. One report ead: "There was considerable rifle fire on the streets. Several of the feeders were shot off with the idea of throwing the town into darkness. I laid on the floor between the two engines, exhorting the engineers and firemen to stick. They had more respect and fear of me than of the stray bullets so we kept the lights burning. Our share of restoring order."

Twenty-four hour service was started; and, with good service, applications for power and lights piled up much beyond plant capacity. Then began a fight to get more equipment. True, income had increased several hundred per cent, and the cost per kw.-hr. had been reduced decidedly. They made a very satisfactory situation, so why not sit tight and enjoy the fruits of achievement? However, the erector finally wore down opposition, and a steam turbine was ordered. While this was not a large machine as turbines go, it was a monster considering local conditions and trucking equipment. Again it was necessary to make the best of what one had, and the outfit shown was assembled. Old rails were cut to length, laid on the ground and the turbine skidded off the car onto them. Then the large carts and beams were assembled around the turbine and the weight lifted by the long stud bolts.

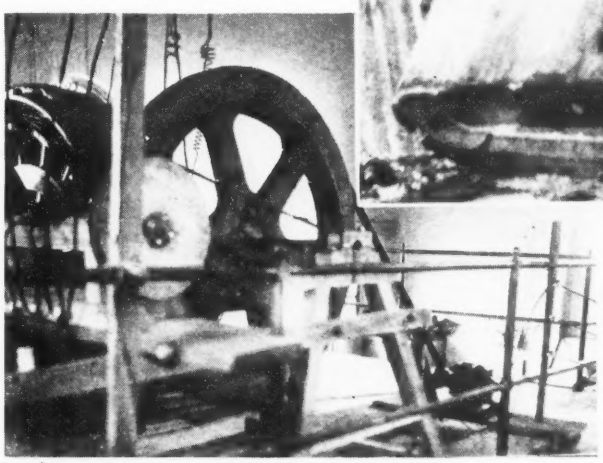
This was the first of several turbines that had to be purchased to take care of insistent demands for service. Extensions and pieces of equipment were secured only after months of argument, quarreling and pleading. Also, there was a constant fight to prevent the plant being "run cheap fashion," with poor oil and the cheapest of supplies.

Persistence and courage, plus ability, won out. Nine years without a shutdown, in a land where a plant had been shut down six weeks to clean the boilers, was an enviable record.

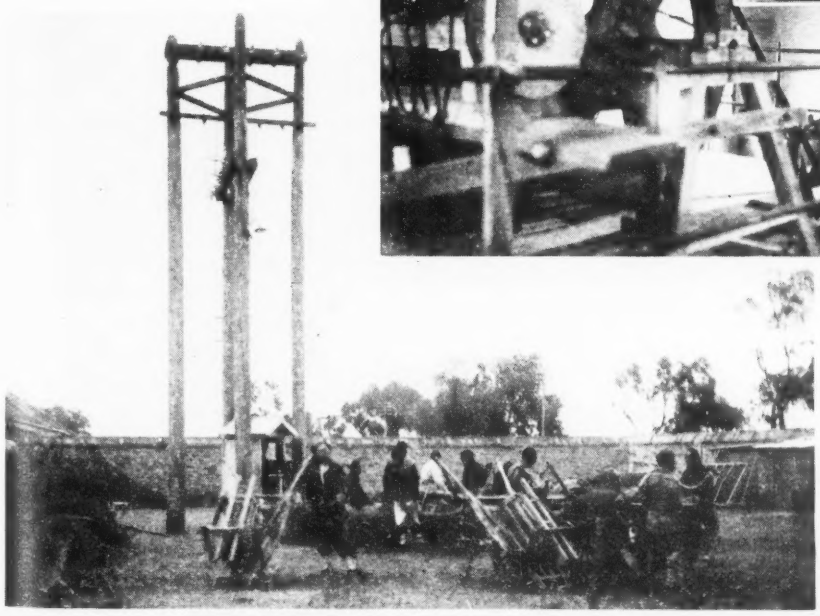




Above — Reinforcing framework and mold for the full-length concrete bathtub—first in the Province



Right — Home-made flasher used for lights on top of the chimney during celebration of first day of the revolution at Wuchang, and earlier for marking plant completion



Left — Coal in sacks and on wheelbarrows — enough for one night's use, about 6 tons

Below—Bringing in a turbine—with wooden wheels, horses, mules and guns

HOW TO BEND PIPE—II

Second part of this simple procedure for bending pipe with usual small-shop equipment. This discusses creased bends and special equipment

By H. R. Riley
Salem, Ore.

AFTER the last bend, the pipe should be left as in Fig. 8*A*, in other words, not quite to the angle finally desired. This is done so that the additional bending induced by final cooling of the pipe will not bring it beyond the final angle desired. It is a difficult operation to straighten a bend if it is bent too far, while it is relatively easy to increase the bend slightly if the original bending did not attain the ultimate angle desired.

In final bending, the more incomplete bends may be increased, as in Fig. 8*B*. At the arrowpoint is shown a bend not as complete as the others. This one can be reheated and further upset.

Fig. 9 shows a close-radius or small-radius bend, but also illustrates the general appearance of the completed bend. In some instances it may be desirable to hammer the upset portion with a small hammer while the metal is hot.

Where bends of extremely short radius are made, as in Fig. 9*A*, the procedure is the same as that for bends of greater radius, except that upsets may overlap as in Fig. 9*B*.

It is advisable to make some arrangement to prevent flattening of the pipe while bending. Two clamps such as those shown in Fig. 10 are helpful and may be placed on each side of the bend while heating and bending.

Double-offset expansion U-bends, such as those in Figs. 11*A* and *B*, are made the same way, making the two outer short bends first, as shown in Fig. 11*C*. It may be desirable to remove the stresses of the metal by reheating and annealing. However, on the average class of work this will be unnecessary if the pipe is covered after making each bend. Worn-out pieces of auto truck brake lining will serve as insulation.

After a welder becomes familiar with the procedure, bends of this type can be made in less time than it takes to describe the process. Gas consumption is surprisingly low, and the noise attendant upon the use of large oil burners with conventional bending methods is eliminated.

Creased Bends

The procedure in making creased bends is exactly the same as that for plain pipe bends, except that an additional heated area and fewer bends are required to make an equal radius. The work is laid out, making provisions for the metal taken up in the deformation for plain bends, plus the metal utilized in the crease itself. The comparison of Figs. 12*A* and *B* gives a general idea of the relatively fewer bending operations in making the creased bend than in making the upset type, because in the creased bend the metal is doubled up. Clamps of the type in Fig. 10 must be used on

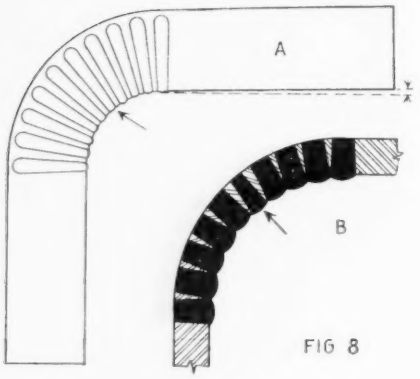


FIG. 8

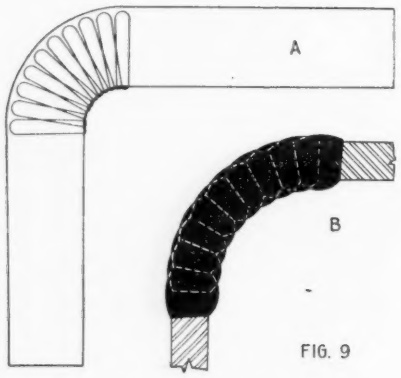


FIG. 9

FIG. 10

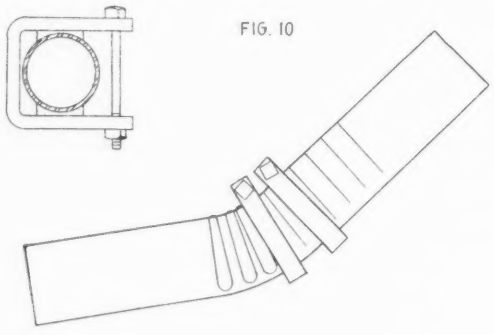


FIG. 11

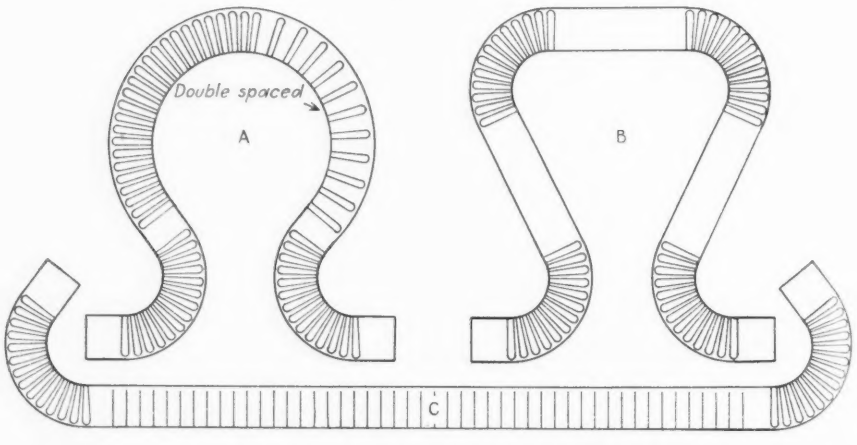


Fig. 8—How to finish the bend to a right angle. Fig. 9 — A short-radius bend, and how upsets may be overlapped to make it. Fig. 10—Clamps to avoid distortion during bending. Fig. 11 — Double-offset expansion U-bends

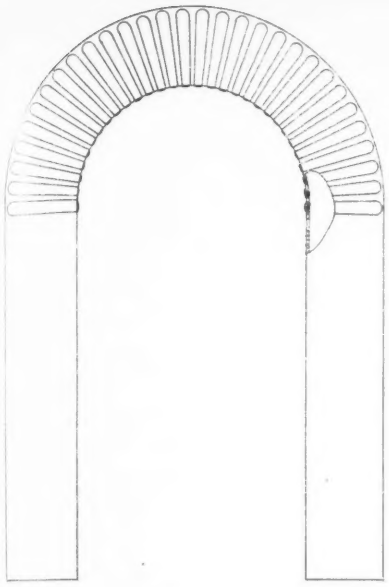


FIG. 12A

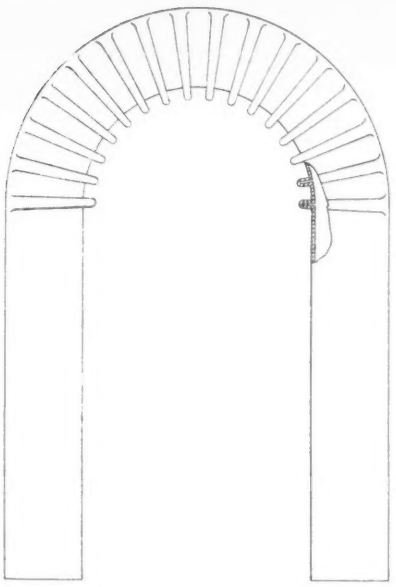


FIG 12 B

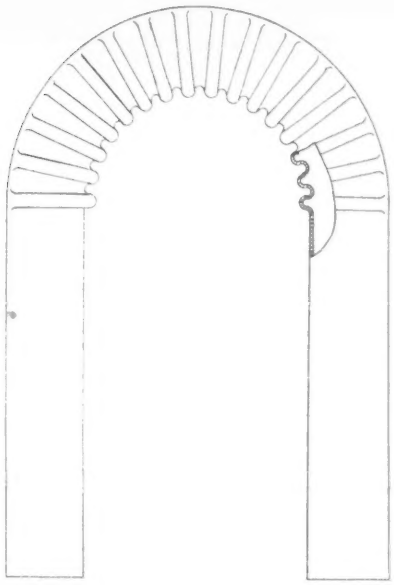


FIG. 13

Fig. 12A—U-bend made by upsetting. Fig. 12B—U-bend made by creasing. Fig. 13—Creased bend suitable for expansion and contraction

short-radius creased bends just as in short-radius plain bends. The procedure is generally the same as that shown in Fig. 4 and Fig. 6*A-B-C*. The pipe is bent as in Figs. 6*D*, 2*D* and 14*A*. More force is applied while heating until the heating band resembles Fig. 14*B*, which is upset more than necessary for a plain bend. At this point bending is stopped, but the shaded portion of Fig. 14*C* is heated as wide on each side of the center of the red hot band as the finished crease is to be heated. For example, a heated area $3\frac{1}{2}$ or 4 in. wide is required for a $1\frac{1}{2}$-in. crease. When the entire shaded portion of *C* is red hot, bending power is applied again, but faster, so that the center of the heated area starts to crease as in *D*. Bending is continued until the crease takes on the shape of *E*, when the cold metal is reached. Creasing will stop and should not be forced beyond this stage. Note the arrow point in Fig. 14*E*. A cut-away section will disclose that the wall is thicker in this part, due to the first deformation.

If it is desired to finish the crease tight with square corners, as in Fig. 14*F*, as soon as the crease has lost the red color, heat is supplied where the arrows point, inside, outside or both, bringing the edges to a bright red, then more bending pressure is applied until the corners take on a more square appearance.

Creases of the type illustrated in Fig. 13 are made by upsetting the metal in the narrow heated area only enough to start the deformation. This makes certain that the crease will be made on the outside of the pipe. Then a wide portion of the band 3 or 4 in. wide is heated, keeping the original center deformation as cool as reasonably possible while bending or while heating.

Bending Tubing

Tubing may be bent just as thicker-walled pipe is bent, except that necessary equipment is smaller. Most of the bending can be accomplished by the welder himself, and usually only one torch is required for heating. Thin-wall tubing will upset and bend very easily if the welder keeps a very narrow circumferential heated area, keeping the torch moving to make a quick heat and to prevent burning or overheating any part of the tube surface.

Multiple-Jet Heating Tip

Where several U-bends are to me made in a given size of pipe, a multiple-jet tip can be made that will work quite satisfactorily. In our case we had a number of bends to be made in 6-in. extra-strength wrought iron. A copper bar $\frac{1}{2}$ x 1 x 8 in. long was drilled the full length with a $\frac{1}{8}$-in. drill. In drilling this hole the bar was centered in a lathe chuck to assure that the hole would be near the center throughout the full length. A slight deflection from center does no harm, as the "tip" is later sized on the outside.

As in Fig. 15*A*, drill 20 holes in one edge of the bar, with a No. 60 drill, starting $\frac{1}{2}$ in. from one end. These holes are spaced $\frac{1}{8}$ in. apart. Skip two spaces in the center, then drill 20 holes on the other end. The space in the center will be under the torch pipe or tip connection and is thus not drilled. Holes in this particular location would receive too much gas pressure. When the drilling is completed the bar is bent around a 7-in. form to shape, as in Fig. 15*B*, or a radius suitable for the particular pipe size (keep the edge of the tip around $\frac{1}{4}$ in. from the surface of the pipe to be heated). When the tubing is bent, the small holes will close slightly as shown in the enlarged section, Fig 15*C*. This is an advantage, as it closes the final orifice slightly and may help to prevent flashing back.

After the tubing is bent, remove the surplus top metal evenly from the center $\frac{1}{8}$-in. hole, tapering to $\frac{1}{4}$ in. thick on the edge with the small holes. In the center of the back drill a hole to admit a discarded $\frac{1}{8}$-in. welding tip. It may be threaded in, brazed in, or both. If the tip is brazed in, the operator must re-

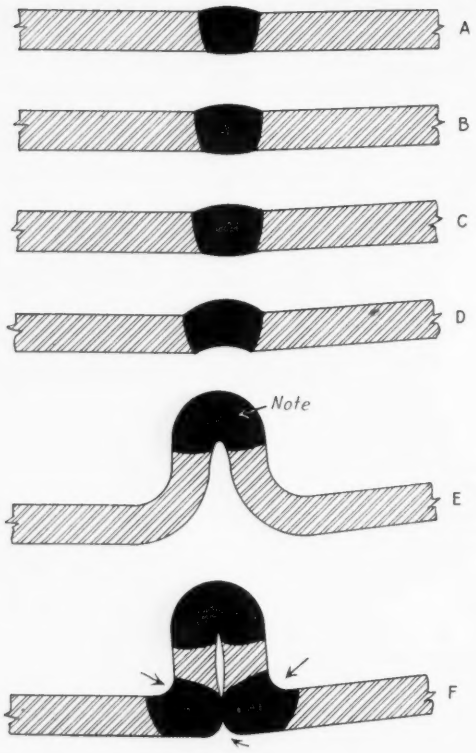


FIG. 14

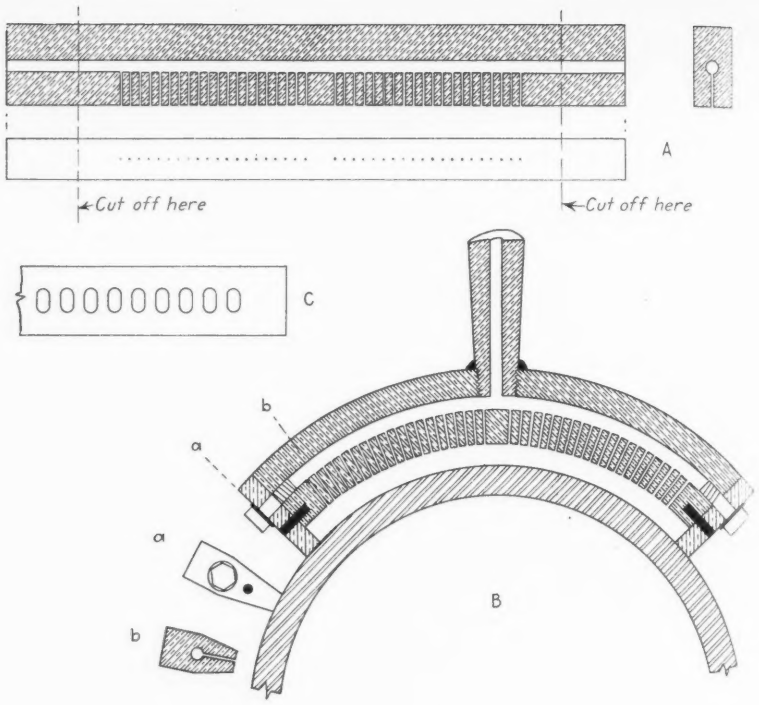


FIG. 15

Fig. 14—Steps in making a creased bend. Fig. 15—Special multiple-jet torch head for heating narrow bands before upsetting or creasing

member to put on a jam nut first if the welding torch is of this design. The $\frac{1}{8}$-in. end holes in the tubing are threaded and plugged with $\frac{1}{4}$-in. brass cap screws, long enough to hold the end lugs. These lugs are extended downward at each end to maintain the torch flame at the proper distance from the pipe.

To ignite a torch of this type, turn on and light a good supply of acetylene, before turning on the oxygen. The torch must be cooled in water before each heat. It will assist in making more workmanlike bends and increasing production speed.

Incidentally, the first creased bend which I made was made by accident. I was working outside in bright sunshine, so that the color was somewhat misleading, and the heated area of the pipe was considerably larger than I expected. A partial crease was the result. My first experiments resulted in a number of crease bends such as those in Fig. 12*B*. Creases were finished as in Fig. 14*F*, with the inner edges tight together. This proved a mistake for the particular purpose these bends were to serve, namely, to compensate for elongation or contraction of high-pressure steam pipe. The creased bends as I first made them were more rigid than the plain bends. Hence, where flexibility is an item, the crease should be left as in Fig. 14*E*, so that there is space in each crease, as in Fig. 13.

Under normal circumstances, however, the plain bend is preferable, because of its smooth surface and simpler mechanical characteristics. While my illustrations show quite a bump where the metal is upset, in actual practice the pipe is practically as smooth in the turns as in any other type of turn, unless the operator extends the individual upset to extreme.

The theory of flexibility of double-offset expansion U-bends advanced by some engineers does not follow out in practice with this particular type of bend. Purchased bends usually retain normal wall thickness. Thus bends patterned as in Fig. 11*A* are preferable to those in Fig. 11*B*. But where my particular type of upsetting is used for plain bends, the bends are more rigid than straight bends. For this reason, bends with long interposed tangents are to be preferred, as in Fig. 11*B*. The actual difference, however, is negligible.

It is also actually possible to make corrugated pipe bends with this method by making half of a crease, then bending the other half. This type is more flexible.

Today's Efficiency

INCREASE in efficiency of generating, distributing and utilizing electricity has reduced its cost, making it possible for the nation's industries (which use 80% of the power produced) in turn to lower their costs. If today's annual 57 billion kw.-hr. of fuel-generated electricity were produced at 1890 efficiency, it would require 280 million tons of coal a year to produce it, instead of the 41 million now used. The cost of this would make prohibitive many of the most important uses to which electric power is now applied. This fuel saving, due to increased generating efficiency, has a dollar value of $2\frac{1}{2}$ millions a day. Because these savings permit so much greater use of electricity, electrical output from fuel in turn has increased so greatly (about 265 times), that the central-station industry now consumes about 36 times the coal it did in 1890.—*General Electric Co.*

SHOE-TYPE GUIDE BEARINGS
For Hydro Generators

By R. Baudry

Power Engineer
Westinghouse Electric & Mfg. Co.

A KINGSBURY thrust bearing is so built that its surfaces are submerged in oil, thus oil circulation is not required. On slow-speed generators, the heat produced by bearing friction is radiated through the oil-pot walls. For high speeds, a water-cooling coil is immersed in the oil. Effective seals have been developed to prevent escape of oil vapor into the machine, so that there is no oil loss. Lubrication of such a bearing is simple and requires little supervision.

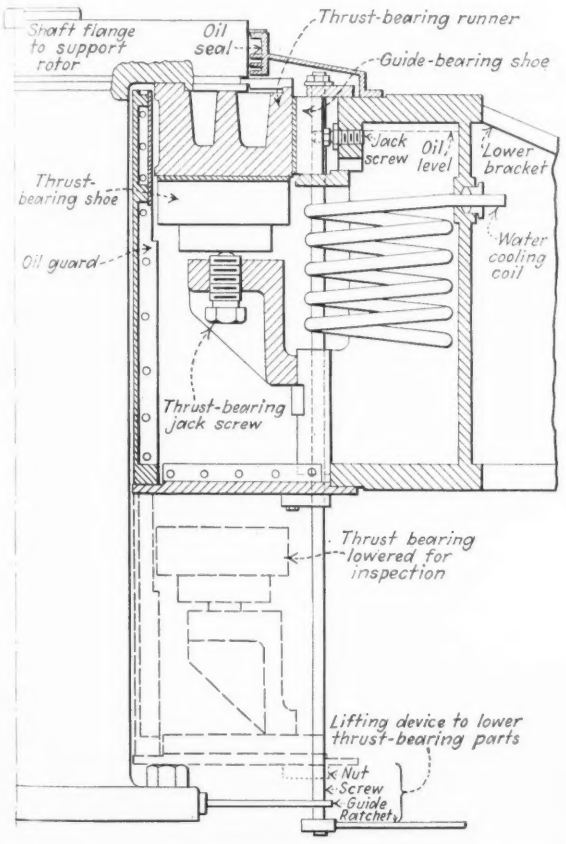


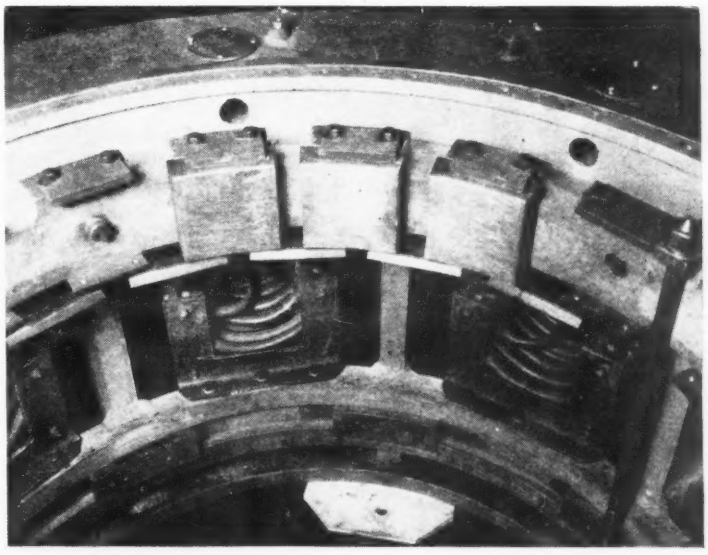
Fig. 1—Section through shoe-type thrust and guide bearing. Dotted lines show thrust shoe in lowered position

Although guide bearings on vertical generators support a light load, their lubrication requires a complicated oiling system. In the conventional vertical waterwheel generator, the oiling system includes a gear-driven oil pump in the oil pan, which circulates oil through a system of piping to the upper and lower guide bearings. Control of the oil flow is by pressure regulators, valves and flow indicators. This system is less reliable than that for thrust bearings and needs considerable supervision, objectionable in automatic power stations.

Many attempts have been made to simplify the conventional guide bearing; one is to locate it on the thrust-bearing-runner periphery below oil level. There the guide bearing is accessible and the oiling system eliminated. Because the peripheral velocity of the runner is higher than that of the shaft, bearing friction losses are larger. To reduce these losses a bearing with a smaller area and a larger than conventional unit-carrying capacity is required, conditions met by a shoe-type bearing, having shoes individually supported on jack screws, Fig. 2. Tests made to compare temperature rise in a shoe-type and a conventional guide bearing, showed that, at the maximum load which could be produced on the available testing machine, the shoe-type bearing was still operating satisfactorily when the conventional unit failed at a much lower load.

Shoe-type guide bearings are particularly suitable for the umbrella-type generator. The shoes are of small size and weight, thus can be readily handled in much less space than the heavy conventional bearing. The lower bearing bracket is made so that the thrust bearing can be lowered with a special lifting device, Fig. 1. This permits periodic inspection of the bearings without disturbing other parts of the machine. To make such an inspection on the conventional vertical generator necessitates removal of the exciters, platform and stairway.

Fig. 2—Part of a shoe-type guide bearing. The thrust bearing is lowered by screws, one of which is shown at extreme right

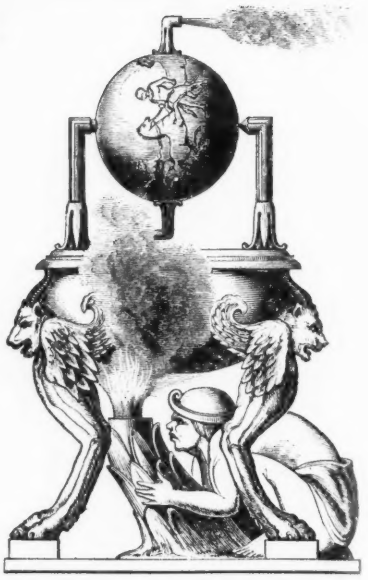


STEAM PLANT ERRORS

Cutting in a Boiler

*By Frank H. Browning, M. E.**

Engineer Examiner for the City of Seattle, Wash.



How do you cut in a boiler—with pressure a little above or a little below, or the same as the others in service? May sound like an easy question, but don't be sure until you have read this dialogue between Mr. Browning and a candidate for an operating license

"WHEN you cut this fresh boiler into service you said you would get the pressures just the same, or as close as you could get them, and then open the main valve."

(Nowadays, many boilers in large batteries have a non-return valve in the steam pipe to the header—a sort of check valve which opens by itself and cuts the boiler in when pressures balance. This prevents other boilers emptying through a damaged boiler when a tube blows out.)

"Say this boiler plant has regular stop valves on the steam line, which you must open by hand. How close do you want the pressures when you open the main valve?"

"Say two or three pounds difference—not over five pounds anyway, 'cause the gage might be off some too."

"Do you prefer the fresh boiler a few pounds above or below the others in service carrying the load?"

"A little higher, if anything."

"Why higher?"

"Well, it wouldn't make much difference."

"It makes this difference. If it is higher, steam will go out when you open the valve, and if the fresh boiler is below the others, some steam will come into it from the header, until they equalize. Which will be better?"

"I'd want the steam to go out."

"That means you want the fresh boiler higher. Why?"

"Why—we shouldn't let steam come back into it."

"Why not? What harm would it do?"

"It would raise pressure on the one we are cutting in."

"Give me something definite. Which is safer—to have a fresh boiler a little higher, to make the first steam go out, or to have less pressure and let steam come into it?"

" . . . I think it would be safer to have it higher."

"Tell me why."

"Why—I imagine, —a—no. . . . I believe it wouldn't be right to let steam back in and raise the pressure."

"What effect would that have? Show me some reason."

"Um . . . I don't know as I can show any reason."

"You've been running in circles. Let's try another line. Do you want the engine to get wet steam or dry steam?"

"I'd want dry steam—dry as I could get it."

"Which way will give it drier steam—cutting the boiler in above or below the pressure of the battery?"

"Cutting it in above the others, of course—the higher pressure steam is drier."

"You are way off the track. Want some help?"

"Guess I must need it then, according to that."

"What will be in the pipe above the dead boiler when it stands cold, with line pressure down to the closed valve?"

"There might be some air—steam and air—er—maybe some water too—sure, there would be some condensation."

"Certainly. It may be full in a couple of days. Where will the water go when you fire this fresh boiler up a little higher than the rest, and make the steam go out?"

"It would go out in the line—I see that now."

"Does it look good to you?"

"No, that was all wrong. That's plain enough now."

*Chapter 5, reprinted with permission from Mr. Browning's book "Steam Plant Errors," published by the Stepler Company, Seattle, Wash. All rights reserved by the authors. *Power* reprinted Chap. 1, "Premises," in August, and Chap. 3, "How Water Acts in a Boiler," in September.

"Sort of prophesying the weather after a storm?"

Some say,

"Look here, Chief, my handbook said to cut a boiler in even or a little above the rest, not lower."

"Does it look reasonable to take a chance on blowing condensation into the main steam line?"

"No, it don't now. That's easy to see. . . . You know—I should have known that, too—but—the book said . . ."

"Never mind that. No book can take the place of using your own head. When something is printed, you fellows swallow it whole for gospel truth, even the half-baked ideas of things that are not in plain sight. The books generally pass along common ideas and habits of the trade. I advise you to talk with other engineers, and study books and trade papers all you can, but don't believe a single thing they say until you know what it means—find out why it is so—follow it through to learn how it works. Then it will be ready to use on your own job.

"This is quite a lecture—to set you straight. Thrash out these subjects until you can explain them to a twelve-year-old boy. So long as things look hard or doubtful, you are still wrong. Get a clear reason for everything. Then you may be surprised at some habits you have learned. . . . Think you can cut in a boiler safely?"

"Yes, sir, thanks a lot. I won't forget it either."

"We're not through yet. After you blew the water into the main steam line, where would it go?"

"It would go along to the engine."

"You can see no ordinary drain or trap could take that slug of water. A separator probably would, if the water got that far without splitting a pipe or valve. What would water do to an engine?—with a big heavy flywheel?"

"I guess it might break something."

"Well, after you had blown the cylinder head through the wall, how much job would you have left?"

"More than likely I'd be all washed up by then. No, sir, that was a bad one—sure enough."

"Tell me what you should have done to make allowance for the condensation above the main valve."

"I meant to drain that out."

"You didn't mention draining the pipe. A drain in the pipe just above the main valve still leaves all the valve spaces full. Want to blow over that much water?"

"No, I wouldn't."

"Then tell me whether it is safer to have the fresh boiler a little higher or lower than the others."

"It had better be below the others. I see now."

"Will it hurt the boiler, to let in a little more water, and a handful or two more steam to equalize the pressure?"

"No, it wouldn't—when you come to think about it."

"Just because you fired up an extra boiler to give more steam and pressure, you thought you wanted more steam pressure on it. Now, say the drain is right in the body of the valve, or in a horizontal pipe, so we can let out all the water and blow steam through it until the pipe is hot too. When you are rid of all condensation, will it be better to cut in higher or lower?"

". . . I don't see as it would make any difference."

"A while ago you said it would give the engine drier steam if cut in with higher pressure, didn't you?"

"Yes, sir."

"You have run an engine, haven't you?"

"Sure."

"What happens when the engine load pulls the pressure down? Does the water stand still?"

"No, it rises some." Many are mixed on this point.

"Good! Does a severe drag ever cause damage?"

"You bet cha. It can carry water over."

"Certainly. Now let's look at the boiler you are cutting in. If it is above the others, steam goes out and pressure drops the same as with an extreme load. If the main valve is opened more than a crack, the fresh boiler may supply most of the steam for the engine until the extra pressure is used, and pull steam down a few pounds pretty quick. What would the water level do then?"

"That would lift, too, and might carry over. . . . But I wouldn't open it fast. I've cut 'em in lots of times."

"Do you really like to flirt with trouble? Or you still believe that cutting in a fresh boiler with higher pressure gives the engine drier steam, do you?"

"No—that's wrong too. That would give wet steam—and water. How is it they never tell a feller those things?"

"Don't ask me. It's safer, but hard work, to make them look easy, and drive them in so you can't forget."

"Well, sir, I got that straight. It'll stick."

"Once again now. With water condensed above the main valve, is it safer to cut a fresh boiler in high or low?"

"Lower."

"Right. Beside that, is it better to have the new one higher, to make steam go out, drop the pressure some, and try to raise water into the engine line, or is it safer to have it slightly lower, let a little steam back in to hold the water quiet until it heats up a trifle more and then starts to work with the battery, with good circulation?"

"Lower, o'course. I can see that, plain as day."

"Most of you men try just the opposite. You start up to the valve when the gages seem to agree, then you crack the main valve and listen, and open it very slowly, and hope nothing will happen, instead of using your brains."

"Say, could I come talk to you again, some other time?"

Some ex-navy men tell us they were ordered to cut an extra boiler in just under line pressure. More of them are positive they were instructed to cut in higher. We believe water acts the same on all ships. Or the training methods may need revision. Most new candidates choose to have the fresh one higher than the battery, rather than lower, until we discuss results as shown here.

Safety comes by knowing of troubles, keeping them clearly in mind, and finding means to avoid them. We do not like engineers who rely on getting the "breaks," or who think nothing is wrong unless they get caught.

An ounce of prevention is worth tons of scrap.

SPEAKING OF POWER

• TO SEE what men are doing and thinking, the editor roams far in a year. Since early spring I have visited scores of towns in South and North Carolina, Georgia, Tennessee and Virginia, and have also spent several days each in Atlantic City, Washington, Boston, Pittsburgh, Philadelphia, Cleveland. Chicago comes next. . . . On these trips I naturally pick up many bits of engineering information—also impressions of what is going on beneath the surface. My latest impression, most vivid yet, comes from Cleveland. The 10-day Machine Tool Show, as I have indicated on page 573, was probably the most remarkable mechanical display in the history of America. Even the machine-tool experts were left gasping. . . . Overheard on the train going home: "Great show, but I'm worried. If I can't sell the president on the idea of replacing all our machine tools I'll be out on the streets in six months, sunk by competition." "Why?" his friend asked. "Well I saw that — — automatic turning out handwheels every 2 seconds. Our machines take 6 seconds, and we're sunk if we don't do something about it."

While in Cleveland I was shocked to pick up the paper and read that a leading citizen of that city, David J. Champion, had passed away. "Dave" Champion, president of the Champion Rivet Company, has for many years been a genial figure at all gatherings of boiler manufacturers. Known everywhere for his strong convictions and great independence, Mr. Champion had nevertheless a profound respect for the rights of other men. He was held in deep affection by his many friends. . . . He will be missed.

Whatever one may think of the rights or wrongs of the recently signed Holding Company Act, certain indirect results are not in line with power-generating economy. For example, the Connecticut Valley Power Exchange, for the past decade a well-handled organization for inter-utility buying and selling of power over the Massachusetts and New York state lines, came to a sudden halt just before the President signed the act. Cutting these connections avoided federal regulation of the Hartford, Connecticut, and Connecticut Light and Power companies, but at the same time, eliminated power exchange economies that have saved consumers a total of two or three million dollars.

When you are buying, get the lowest price, of course, as long as your bargain hunting doesn't endanger the real quality of the goods. Avoid sweating the seller so hard that he, in turn, must sweat the goods to break even. In this connection I've heard of several cases recently where manufacturers were under such pressure to cut the price of a complete power unit that they in turn had to sell the user on the idea that certain accessories considerably cheaper than those originally specified would be "just as good". . . . All of which reminds me of the old saw, "You can't get blood out of a turnip.". . . As a buyer you can chisel on price just so far. After that the folks you deal with may be forced to chisel, too, so your "bargain" may not be so cheap after all.

We've all heard of the jacknife that was replaced a little bit at a time, one year a blade, another a slab of bone, and so on. After many years each part had been renewed. Still, it was the same old jacknife. . . . One feels a little this way in reading about the remarkable operating results obtained in the very old stations of the Interborough Rapid Transit Co., page 574. The story as presented stresses the savings made by better operation. On studying the historical tabulation it will be found, however, that practically every operating change involved some new equipment or new parts. There is room to mention only a few: New combustion meters, stoker parts of improved design, boiler baffles, air nozzles, added superheater surface, centrifugal pumps, air-cooled furnace walls, new turbine nozzles, new oil coolers, new bleeder connections on turbines, improved intake screens, chlorinating plants, steam-jet vacuum pumps, revamped pipe covering. . . . With the "core," at least, of the original boilers, engines and turbines still in operation, these Interborough plants cannot be said to be "modernized" in the strict sense. On the other hand, improved results were certainly not obtained by "operation" alone, again in the strict sense of the word. . . . The fact is that improved results generally involve both better equipment and improved operating methods.

It is hard sometimes to show a man how big his job really is, and how closely it is interrelated with many others. It is just as hard to prove to a man that he cannot become a narrow specialist on one small element of a power plant and expect to achieve success as a power engineer. . . . An example that comes to mind is the younger fellow who is very much interested in diesel engines and wants to get a job operating one. But he forgets that a diesel must drive something—be it lineshaft, generator, compressor, or pump—and that the man that runs the engine is expected to take care of the driven machine too. It's like a coachman who figures his job is tending to the horse and that somebody else will take care of the coach. It just doesn't work out that way. . . . As a "road map" for the convenience of readers, *Power* has been using a special contents page for some months, a page that cross-indexes all major articles and departments, and indicates into what fields the particular article falls. . . . Use it—it will save you valuable minutes in finding a particular article or in being certain that you've seen all the articles on your special interests in a particular copy.

PHIL SWAIN
Editor

Photo from Wide World ©Fairchild Aerial Surveys

MIGHTY MIDGET

MIDGET in this 200-sq. mi. aerial photograph, but mighty enough to impound waters flowing from Colorado, Montana, Utah and New Mexico, Boulder Dam can hold back a 3-year flow of the Colorado River. This photograph, taken from 20,000 ft. in the air with the new 10-lens camera of the U. S. Coast & Geodetic Survey, shows Boulder Lake level early in August. Water from this mightiest of man-made lakes is restrained by the tiny dam at bottom right

•

How To Save Money By Correct Trapping

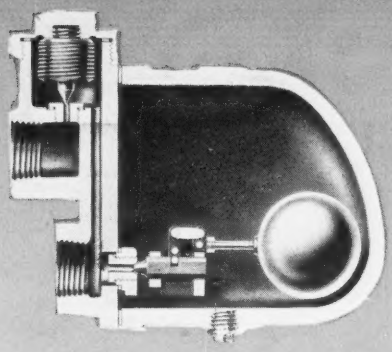
PRACTICALLY every manufacturer who makes only *one* type of steam trap tells you that his trap is the best for *every condition*. Quite naturally, ALL of these steam traps can't be the best for every purpose — nor equally good.

The truth is that no *one* steam trap is suitable for *every* job. And by using the same type of trap for every industrial application, large sums of money are wasted. That's why Sarco Steam Traps are made in so many different types.

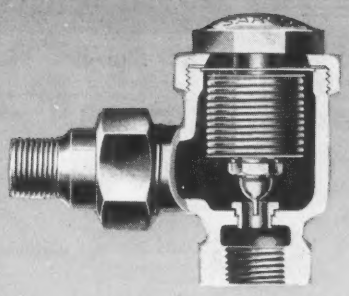
If our experience of nearly a quarter of a century had shown that one type of trap could properly take care of every condition we, too, could save money by making only one trap.

Sarco type 9-2 Thermostatic Steam Trap will give the best service for individually trapping most steam heated process equipment

SARCO STEAM TRAPS



Sarco Float and Thermostatic Trap, for unit heaters, indirect heating, stacks, risers, mains, etc., for high or low pressures.



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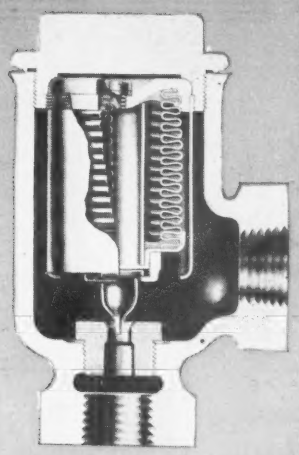

Sarco Thermostatic Steam Trap 9-200, for all process heating equipment up to 200 lbs. pressure.

using pressures from 0 to 125 lbs. If pressures go up to 200 lbs., then we recommend type 9-200. When condensate must be moved as fast as it forms, regardless of the heat units thus lost, then Sarco Float Traps are best adapted. On extensive systems, where condensate cannot be returned to the boiler, and where it is desirable that only cool condensate be discharged with a minimum of "flash" steam even at pressures up to 300 lbs., the Sarco type 8 is the most economical trap to use.

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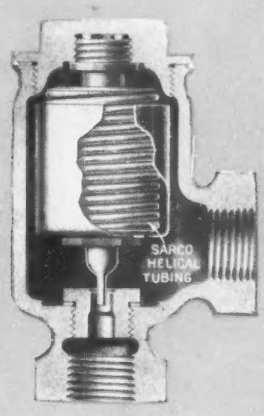

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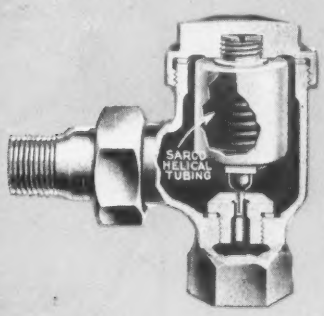

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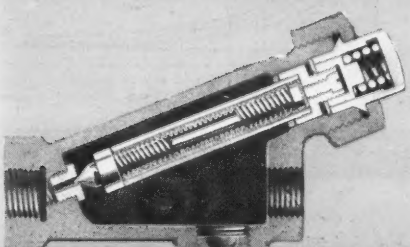

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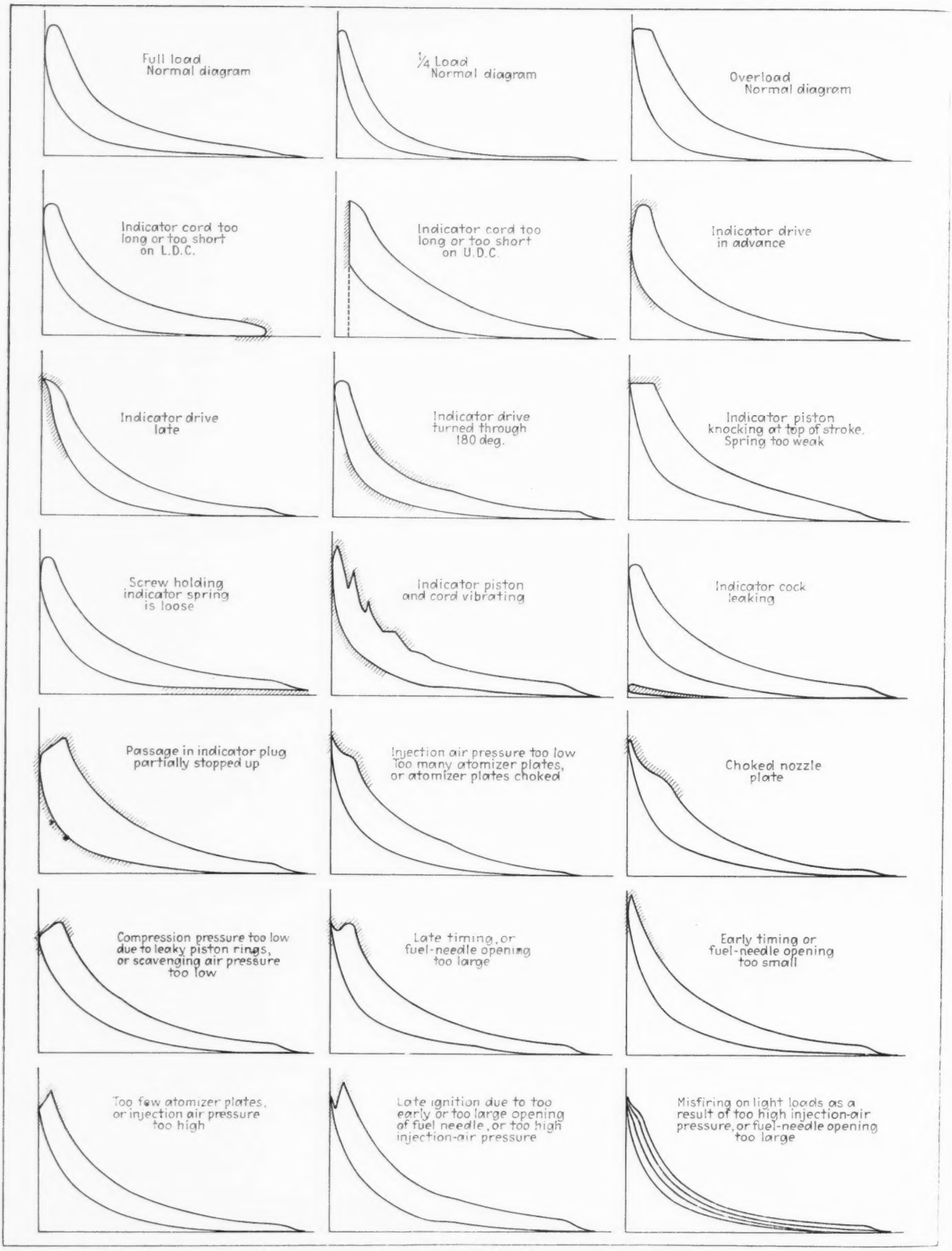
Indicator Diagrams—Diesel Engine


Full load
Normal diagram
¼ Load
Normal diagram
Overload
Normal diagram
Indicator cord too long or too short on L.D.C.
Indicator cord too long or too short on U.D.C.
Indicator drive in advance
Indicator drive late
Indicator drive turned through 180 deg.
Indicator piston knocking at top of stroke. Spring too weak
Screw holding indicator spring is loose
Indicator piston and cord vibrating
Indicator cock leaking
Passage in indicator plug partially stopped up
Injection air pressure too low Too many atomizer plates, or atomizer plates choked
Choked nozzle plate
Compression pressure too low due to leaky piston rings, or scavenging air pressure too low
Late timing, or fuel-needle opening too large
Early timing or fuel-needle opening too small
Too few atomizer plates, or injection air pressure too high
Late ignition due to too early or too large opening of fuel needle, or too high injection-air pressure
Misfiring on light loads as a result of too high injection-air pressure, or fuel-needle opening too large

Diagrams courtesy Busch-Sulzer Bros.-Diesel Engine Co.

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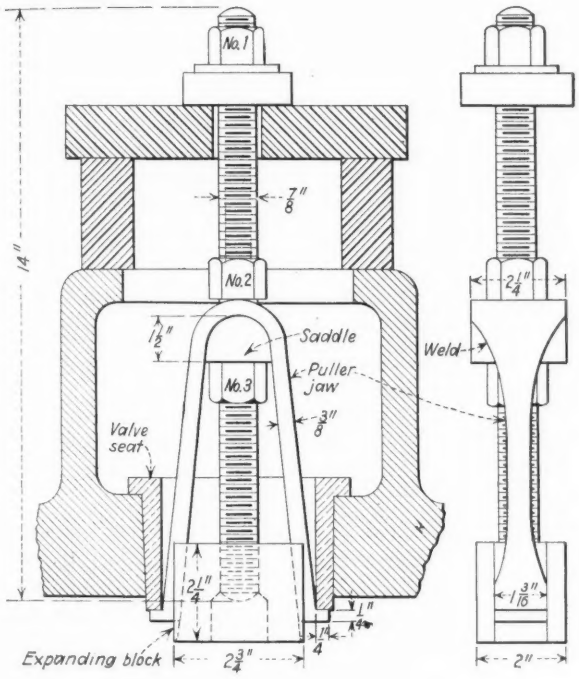


Valve-Seat Puller That Does the Job Easily

THIS pot-valve seat puller was designed by our machine-shop foreman, and I consider it the best that I have ever seen. Any one who has pulled seats out of this type valve will recognize its merits.

The puller is easily made; dimensions can be varied to suit conditions. In our case, on a 10x6x10-in. duplex pump, the puller stem jaw saddle, puller jaws and expanding block dimensions are given in the figure. A hole drilled through the center of the saddle and puller jaw is large enough to allow them to slide easily over the stem. Jaws are made of one piece of tool steel approximately 8 in. long and welded to the saddle to keep the two together and make them easier to manipulate. The ends of the jaws have a shoulder that goes under the valve seat. The expanding block has a tapered slot $\frac{1}{4}$ in. deep at the top and $\frac{1}{16}$ in. deep at the bottom. This slot can be cut easily on a shaper or milling machine. Nuts 1, 2 and 3 are standard and should turn easily by hand.

The diagram shows the puller in position with the necessary blocking needed to remove the valve seat. To place it in this position, remove No. 1 nut and all washers and blocking between it and No. 2 nut. Turn No. 3 nut to move it in the direction of the expanding block a few threads. Unscrew No. 2 nut until the saddle can rise up far enough for the jaws to come to the top of the expanding block. Insert the puller jaws under the valve seat and screw down on No. 2 nut until the saddle can rise up far enough for the jaws to come to the top of the expanding block. Insert the puller jaws under the valve seat and screw down on No. 2 nut until the expanding block is raised far enough to force the jaws firmly against the throat of the valve seat. Now turn No. 3 nut until it is hard against the jaw saddle. Because the hole in the saddle allows it to slide on the stem this nut takes all of the stress in removing the seat. The necessary blocking is now put into position and No. 1 nut put on the stem. By screwing down on this nut the valve seat is pulled up and out of the casting.

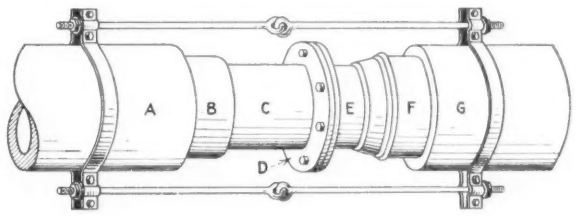
With this puller there is no slipping once it is in position and ready for pulling. One mechanic can renew all the valves of this type in a duplex pump in a very short time.

Rockland, Mass. BURTON W. WHEELER

Waterwheel Connection to Wooden-Pipe Line

COMPLETION of laying a 2-mi. wooden pipeline down to the plant found the waterwheels bolted down, making pipe bends and turns necessary at points where there was a tendency for the pipe to come apart when under heavy pressure.

In making a joint in wooden pipe it is the common practice to raise up both male ends, *B* and *F*, and thrust them into the joining wooden collar, dropping the pipe and forcing the collar up tight to the pipe-end shoulders. Instead of using the collar, I made the connection as in the diagram. This is more conveniently connected, especially at a pipeline end that cannot be raised to make the joint. I screwed a 4-in. pipe nipple *C* into the wooden pipe male end of pipe *A* and put a pipe flange on the other end of the nipple. This flange bolts to a flanged soil pipe fitting *E*, driven on to the male-end of pipe *G*, a short length leading to the waterwheel. Since the pressure was about 80 lbs. per sq.in. on this line,



two pipe clamps and tie rods were used to hold the joint tight. The male end of the wooden pipe was fitted fairly snug, in the soil pipe end, by working it down with a wood rasp, and when wet made a tight joint.

Vancouver, B. C. S. H. COOKE

Rotary Converter Operates With Shunt Field Open

A 300-KW. compound-wound rotary converter supplies direct current for a load of variable-speed motors that must be kept in constant operation during working hours. After a few-months operation it was noticed that the ammeter on the alternating-current side of the machine read 475 amp., 415 amp. being full-load current. Since the converter continued to operate without dangerous heating, shutting down was postponed for several hours, until the end of the day.

The cause of the increase in current proved to be a burned-out resistor tube in the converter shunt-field rheostat. With the shunt-field circuit open, the field poles were magnetized by the series field winding only, the remainder of the excita-

tion being produced by lagging currents in the converter armature. Operation with the shunt-field rheostat cut out was not feasible in this particular installation because of the high-direct-current voltage produced. The defective resistor was replaced with a spare fortunately on hand.

This failure indicated that load could be carried satisfactorily on the converter without current in the shunt field winding. To have warning of undue heating a discarded overcurrent relay was connected in series with one of the converter's overcurrent relays, and arranged to ring a bell when the current became 400 amp.

Oakland, Calif. RALPH BARR GLENN

1.5-Hp. Pump Replaces 15-Hp. Unit

MANY industrial plants during the past few years have pursued a policy of limiting capital expenditures even though it meant the operation of their equipment at inefficient ratings. That this may be false economy in many cases is aptly illustrated by the following recent experience in one plant:

The plant had a hot-water, single-stage, double-suction circulating pump purchased about 1912. This pump had 3-in. suction and 2½-in. discharge and was originally rated at 200 g.p.m. against a total head of 100 ft. and was driven by a 15-hp. squirrelcage motor at 1,745 r.p.m. The characteristic curves furnished with this pump when originally sold are shown by the full-line curves.

Originally this pump discharged through a heat exchanger and a long complicated arrangement of piping, which account for the high head required. Later the heat exchanger was discarded and the piping arrangement simplified. After this, we found that only 130 g.p.m. against a total head of 27 ft. was required. Rather than purchase a new pump, the old one was used, ignoring that it was much too large for the job.

Several months ago I had occasion to check operation of the pumps in this plant, and the inefficiency of the pump in question stuck out like a sore thumb. It did not require very much sales ability to have this unit replaced with a new one when the operating engineer realized the saving that could be realized.

To replace the old unit, a close-coupled pump was installed having a 3-in. suction and 2-in. discharge, driven by a 1.5-hp. motor. The characteristics of this pump are indicated by the dotted curves. With the new pump costing a little over $100 complete with motor, the saving in power compared with that to operate the 15-hp. unit, will pay for the new installation in a few months.

There are probably many similar cases where antiquated equipment is being operated to save the expense of purchasing new, when real economy dictates the installation of modern pumps and new equipment would pay for itself in a fairly short period.

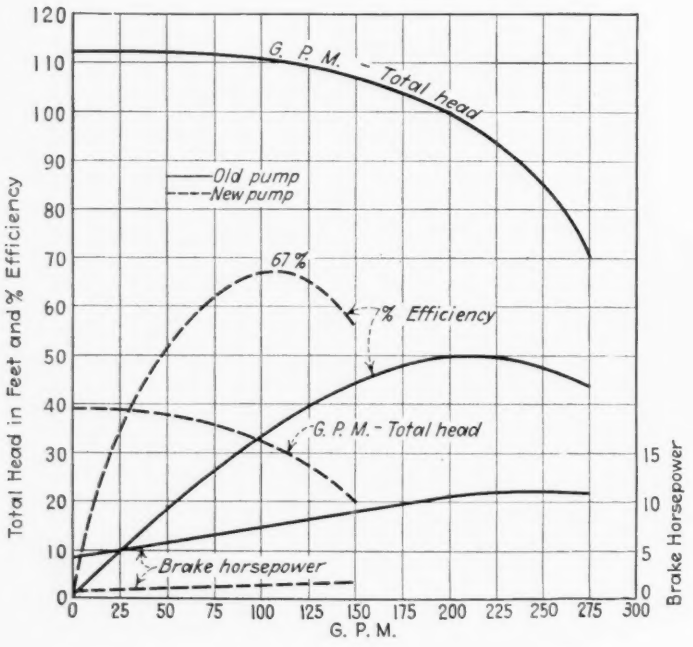
New York, N. Y. K. A. FRANK

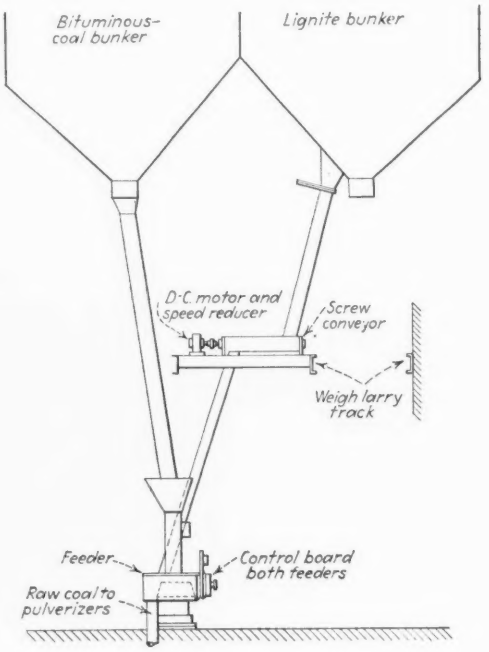
Burns Bituminous Coal and Lignite in Combination

EXPERIENCE shows that it is practically impossible to mix coals of widely different characteristics satisfactorily in a bunker or a stoker hopper. In one plant, where bituminous and lignite were burned in combination, uniform feed of each coal was obtained by using two separate feeders discharging into the same raw-coal supply pipe to the pulverizer.

The 16,000-sq.ft. boiler was served by three pulverizers (two 4-ton impact-type units and one 6-ton ball-type unit). The 500-ton bunker directly overhead was divided in the center, one-half being used for bituminous and the other for lignite. A 12-in. pipe was welded into the inclined bottom of the lignite bunker near the gate for filling the weigh larry supplying the stoker-fired boilers directly opposite.

A short section of screw conveyor, mounted on the larry-track level to serve as a feeder for the lignite, was driven through a reduction gear by a d.c. motor with separately excited shunt field. Control for this motor and regular feeder motor were mounted near the feeder on the operating-





floor level. The discharge pipe from the screw conveyor was connected to the top of the regular feeder at a position where the lignite would just tumble off the table when it is at rest. This allows feeding lignite only if desired, while by operating both feeders together, any proportion of either coal can be fed to the mill.

From a series of tests, a graph was made showing that amount of lignite fed at different settings of the motor rheostat. At periods of light load a higher proportion of lignite than bituminous is used, while at other loads the amount of lignite is reduced. On peak loads the lignite is cut off entirely.

The separate bunker and feeder is also convenient for testing different coals. The test coal can be stored and fed to the boiler at any time without interfering with the regular coal supply to the three mills.

Winnipeg, Man. C. L. ALEXANDER

Feed-Water Heater Made of Pipe and Fittings

WE OPERATE a central steam-heating plant. Part of our meters are so located that we can return about 25% of the condensate to the plant, so that it is necessary to use about 75% make-up feed water. It became necessary to

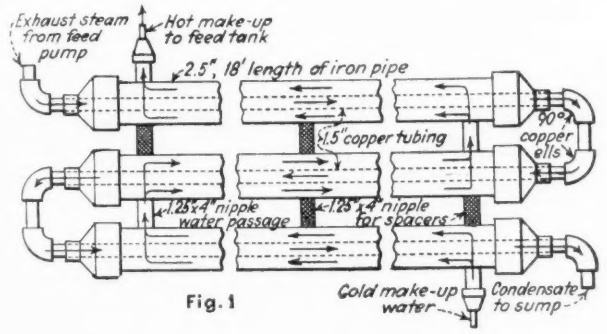

Exhaust steam from feed pump
Hot make-up to feed tank
2.5", 18' length of iron pipe
1.5" copper tubing
90° copper ells
1.25"x4" nipple water passage
1.25"x4" nipple for spacers
Cold make-up water
Condensate to sump

Fig. 1

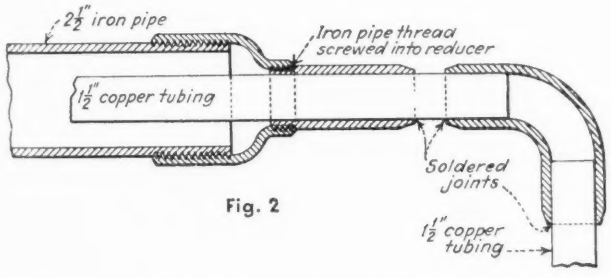


Fig. 2

install a new feedwater heater, for which space and cost were factors.

The new heater, Fig. 1, was made of three lengths of 2.5-in. standard iron pipe 18 ft. long and the other material indicated on the drawing. A welder was called in to cut holes in the 2.5-in. pipe and weld in the nipples for water passages and spacers between the pipes. The heater is supported from the steel work on the side of one boiler, consequently takes very little floor space.

Before the iron and copper pipes were assembled, the six copper couplings were machined to an inside diameter equal to the outside diameter of the copper tubing. The copper tubing was then put into the 2½-in. pipe and the reducers put into place and screwed onto the iron pipe. Next the couplings were pushed onto the copper tubing and screwed into the reducers. Make-up of this assembly is shown in Fig. 2. To complete the assembly the elbows, with the connection between them, were slipped onto the end of the copper pipe. When the assembly was completed, the copper-to-copper joints between tubing and fittings were heated and soldered.

Cost of material and welder time amounted to $59.50. Valves, piping and other material outside of the heater cost $35. It is expected that the saving in fuel due to the heater will pay its total cost of $95.50 in about six months of operation.

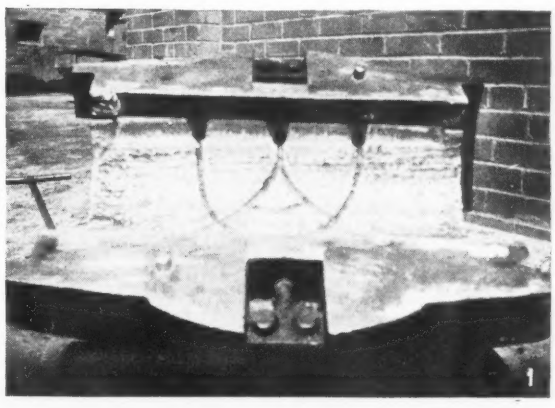
Los Angeles, Calif. LAWRENCE B. BROWN

Turbine-Generator Bearing Repaired by Welding

WE HAVE repaired one of our Canon-City turbine-generator end bearings in a rather unusual although practical way. The surface of the bearing, which had worn about 0.020 in., was first cleaned and then its surface was built up about ⅛ in. by welding with a good grade of babbitt. This babbitt fuses securely on the surface of the old babbitt. Several tests by cutting with a chisel showed complete fusion between the new and old babbitts. A No. 5 acetylene welding tip was used to do the job.

Figs. 1 and 2 shows the bottom half of the bearing after welding and after machining. The jig, Fig. 2, was used on the lathe carriage, one at each end for holding the bearing while machining with a boring bar. About eight hours was required for building up the bearing, a large saving in time and cost compared to the usual way of doing the job. As shown in Fig. 1, when welding all clearances and oil grooves were kept free of babbitt.

Pueblo, Cal. GEORGE W. DEVINE
Assistant Master Mechanic
So. Colorado, Power Co.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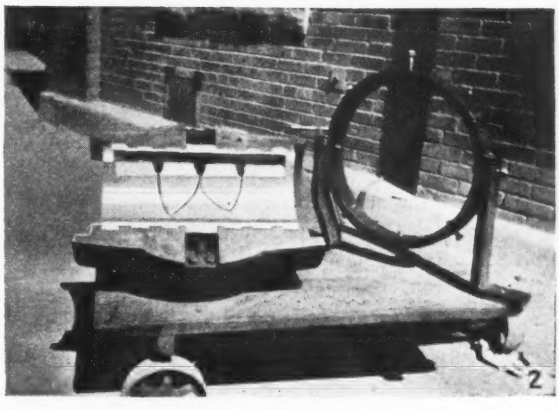
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CURRENT COMMENT

Coal Consumption in British Plant

I AM interested in David Brownlie's paper entitled "The Price of Clean Stacks," which appears in the August issue of *Power*. It is a live subject and well analyzed, but I believe there is an error in the figures, which, although not affecting the results, is apt to be misleading.

In discussing a 120,000-kw. plant, he assumes 25,000 lb. of coal per hour under peak conditions, whereas a plant of that capacity running at maximum rating for an hour would generate 120,000 kw.-hr., which at 1½ lb. of coal per kw.-hr. would be 180,000 lb. per hour, instead of 25,000 lb. as stated.

If the coal consumption per kilowatt-hour were taken at 2 lb. and a little over, it would amount to 250,000 lb. for the peak hour, in which case a slip of the decimal point might have produced the figure which appears in the article.

Chicago, Ill. W. L. ABBOTT
Chief Operating Engineer, Commonwealth Edison Co.

We have checked back on Mr. Brownlie's manuscript and find that in his abstracting of data from the original report, he left out the words "per boiler" on the figure for coal required. Thus, as there are six boilers working, coal consumption is 150,000 lb. per hr. Coal consumption used in the author's later computations is 1.2 lb. per kw.-hr.—*Editor.*

Efficiency of All Auxiliaries Is Important

THERE have appeared in recent issues of *Power* a number of discussions dealing with heat-balance losses incidental to inefficient or inefficiently operated steam-driven auxiliary equipment. It is generally agreed that operation of uneconomical steam-driven auxiliaries is costly wherever exhaust steam is wasted or steam bled from prime movers or other sources is available for feedwater heating.

When considering auxiliary power wastes, it is well to remember that losses are not confined to steam-driven equipment. Electrically driven auxiliaries are often very wasteful. Some of the factors contributing to wasteful operation of motor-driven auxiliaries are: wrong motor application, faulty operating procedure, poor economy of driven unit and improper scheduling of intermittently operated equipment.

A widespread misconception exists among operators of industrial power plants concerning the dollar savings to be secured by attention to the efficiency of motor-driven equipment. In the great majority of these plants, part of the electrical demand is generated as a by-product of process-steam requirements and the remainder by condensing operation. Costs per kilowatt are usually calculated on an over-all basis and are low—often so low that savings resulting from attention to the efficiency of motor-driven auxiliary equipment are apparently negligible.

It must be remembered, however, that this per kilowatt cost is an average of the low cost of power generated by bleeder or non-condensing operation and the higher cost of power generated by condensing operation. The economics of any decrease of electrical load must be calculated on the basis of the cost of condensing operation. This holds true until the electrical load is reduced to a point where all power is generated as a by-product of process steam, and no loss to the condenser occurs. Consideration of auxiliary electrical power economics from this angle will often reveal opportunities for substantial cost reductions.

Lack of accurate knowledge as to the quantities of steam and electricity consumed by auxiliary equipment is often responsible for indifference to possible waste. Wherever possible, auxiliary energy consumption should be metered. Flowmeters on auxiliary steam headers and watt-hour meters on station service electrical feeders will do much to indicate excessive consumption. In the absence of meters properly interpreted, periodic steam consumption and power input tests will assist in revealing losses.

Waynesboro, Va. S. H. COLEMAN

Preventing Explosions in Compressed-Air Systems

CONTRIBUTORS to the question on compressed-air explosions in July seem to agree that the explosions or fires begin at the compressor, and that a leaky valve is the probable cause. I believe they are correct. When they say, however, that high temperature caused by a leaky valve explodes the mixture of oil vapor and air immediately surrounding the valve, then I wish to be shown.

It is more probable that combustible matter, such as oil-soaked dust surrounding the valve, is ignited by the high temperature of the valve. The fire, once started, is carried forward with the air current, increasing as it progresses. Oil may then be vaporized rapidly enough to produce an explosive mixture. Some authorities claim that a leaky valve will not increase in temperature, but we have located leaky valves because their temperature became sufficiently high to cause oil on the valve cover to smoke.

I remember taking charge of a plant once and removing 13 pails of oil from the receiver. What a fire that would have made! But it didn't. On another occasion the piston-rod packing caught fire, but there was no explosion. It happened to be on the high-pressure side of a 2-stage air compressor and the burning packing was blown outward because there was always pressure in the cylinder. Lack of jacket and intercooler water was the cause of the fire, the water having been shut off for several hours. The engineer in charge was not very observing.

The value of fusible plugs in the discharge pipe as a "prophylactic" is extremely doubtful. If the fire is caused by a leaky valve the temperature of the air will not be raised sufficiently to melt the plug before a fire starts. If plugs blow because of a fire inside the pipe, the fire will be beyond them before they blow. When they do blow they will belch flame. My advice to those using fusible plugs for such a purpose is to get rid of them as quickly as possible. If the temperature of the air is high through lack of cooling water, the plugs might be of some use, but in that case one would be enough to give an alarm, which is all that is needed.

Toronto, Ont. R. MCLAREN

Ask the Operator For the Answer

MANY young technically trained engineers, as well as some who are old enough to know better, make a great mistake in not paying more serious attention to information furnished by practical operating men, such as firemen and others, who are perhaps deficient in a knowledge of engineering theory.

When a fireman tells you that a certain thing happened, it is quite safe to assume that that thing, or something which had the appearance of that thing, actually did happen. The fact that the fireman volunteers an explanation which appears ridiculous does not affect the value of the original statement, and moreover, in all probability this explanation is based upon some other actual occurrence which appeared to him to bear a relationship to the first one.

The work of the professional engineer has often a great similarity to that of a detective. Something occurs and it is up to him to find out why. No competent detective would make the mistake of ignoring the value of information describing other things which occurred at or near the same time.

It is not necessarily the business of the non-technically educated operating man to furnish scientific explanations of his experiences. That is the task of the scientifically trained engineer, and no professional engineer worthy of the name should rest content until he has found the solution of as many of such problems as he can.

If any young engineer will follow this principle, he may possibly find that he will gain more fundamental knowledge of his profession by talking to a fireman than he would if he spent the same amount of time talking to a college professor.

Bloomfield, N. J. JAMES O. G. GIBBONS
Consulting Engineer.

Constant-Level Oilers

THE article "Constant-Level Oilers Give Lubrication Insurance," in July *Power,* covers a very important development in the field of lubrication, but there are other features of this problem to which I wish to call attention.

Experience shows that constant-level vacuum-controlled lubricators on bearings reduce their oil consumption from 50 to 75% of that required with conventional methods. In addition, maintenance costs are reduced and equipment reliability increased, as mentioned in the article.

To many engineers constant-level lubricator applications are confined to conventional-type bearings on motors, line-shafts and similar conditions. They are, however, being used on many other applications.

Results obtained with constant-level lubricators on small splash-lubricated air compressors are interesting. An oversupply of oil in the crankcase of these compressors causes excessive oil on cylinder walls that works ahead of the piston and out into the compressed-air system. This oil mixes with dirt in the air and forms carbon on the piston rings and valves. It also forms oil deposits in the air piping and receiver. Piston rings and valves stick and reduce compressor efficiency, and the resulting high air temperature, combined with oil deposits in the air system, creates an explosion hazard. To prevent these conditions, constant-level lubricators have been applied to maintain crankcase oil at a correct level and to ameliorate the bad effects of over-lubrication.

On internal combustion engines constant-level lubricators are also being applied to hold a constant level of the crankcase lubricant. Before the application of a constant-level lubricator on a 150-hp., 3-cyl. gas engine it used 72 gal. of lubricating oil per month. In addition, considerable trouble was experienced from smoky exhaust, faulty ignition, and carbon deposits and the entire engine was covered with a film of oil. After installation of a constant-level lubricator on the crank case, oil consumption dropped to 24 gal. per month and the other troubles were eliminated.

The case mentioned may seem to be an exception, but it is substantiated by tests made on an 85-hp., 3-cyl., vertical gas engine. Operation of this engine was quite unsatisfactory because of high lubricating-oil consumption and other conditions mentioned for the other installation. Applying a constant-level lubricator on this engine reduced lubricating oil consumption over 70%, and eliminated the other objectionable conditions.

Bearings subjected to windage and in which the oil is violently agitated do not readily lend themselves to the application of conventional-type, constant-level lubricators. In these bearings the oil becomes filled with tiny air bubbles that work through the lubricator connection and up into the oil reservoir. These bubbles reduce the vacuum in the lubricator and allow oil to flow to the bearing regardless of oil level. For such applications a baffle-type, constant-level lubricator has been developed that properly controls the oil flow. The baffle prevents the bubbles from getting into the lubricator and discharges them to the atmosphere.

These and other special lubricating problems are being solved by constant-level lubricators.

Pittsburgh, Pa. FREDERICK WILKES,
President,
National Industrial Products Corp.

Operation of 6-In. Valve From a Belt Step

H. MOORE'S description of a step to reach an inaccessible valve, June *Power* shows the belt step suspended from the 6-in. line adjacent to the valve. The distance from the center line of the pipe to the rim of the handwheel on standard 6-in. gate valves is 20 to 26 in., the handwheel is usually about 9 to 10 in. in diameter, and it requires from 12 to 18 full turns to open or close such a valve. It is therefore obvious that the operation described by Mr. Moore is quite an acrobatic stunt. I doubt if the safety inspector would approve of that mode of operation. There are several other ways to accomplish the same end more conveniently.

A wheel and chain may be used. If the chain is in the way it could be suspended to one side by the method suggested in the same number by S. H. Coleman.

The valve handwheel could be turned downward. If the wheel was 2 ft. beyond reach this may just about bring it within handy distance and still give comfortable headroom. The valve need not be turned all the way down, but 30 or 45 deg., just to bring it within reach.

Mr. Moore suggests that the belt-step could be moved along the pipe out of the way near the wall. If that be the case, it shows that the pipe line near the valve is unobstructed, then why not move the valve near the wall?

Pittsburgh, Pa. BERNARD KRAMER

WHO IS LIABLE?

By Leo T. Parker

Attorney at Law, Cincinnati

CONTRARY to the opinion of most people, circumstances are numerous under which a plant engineer or mechanical engineer may be personally liable on contracts and agreements made while acting as general supervisor of power service in a factory, public building, or institution.

The law classifies employees as either "general" or "special" agents of their employers. Also, the courts have consistently held that an employer is liable for all acts of general agents, which are relevant to the employment, but that he is responsible for only such acts that a special agent performs within the actual scope of the authority given him.

An ordinary workman is a special agent whose implied authority extends no further than to perform the *exact* duties assigned to him. On the other hand, an employer is liable for all contracts made by a manager, such as an engineer, with respect to the ordinary character of the business, if the other party to the contract believes the engineer had proper authority to make the contract and the employer did not notify him that the engineer's authority was limited.

Engineer Is Personally Liable

Irrespective of whether an employer is responsible for the acts and contracts made by an engineer, the latter may be personally responsible on contracts made for his employer. Therefore, it is important to know that, using as a basis higher Court cases decided during the past two years, the following rule has been formulated:

An engineer is personally liable (1) if he makes a false written or oral statement or representation of his authority with intent to deceive a person who intends to transact business with his employer; (2) or, if he performs any unlawful act with or without authority of his employer; (3) or, if he performs a damaging or injurious act although believing that he has authority, but actually has none; (4) or, if he wilfully performs an act which results in damage to any one; (5) or, if he does damaging acts outside his scope of authority, although while so doing he intends to render his employer a valuable service; (6) or, if he intentionally assumes an obligation for his employer; (7) or, if he unintentionally but legally assumes an obligation while performing services for his employer.

Very often litigation arises where an engineer makes a contract for his employer but in fact he makes himself personally liable, without obligating the employer in any way. In other instances the engineer and his employer are jointly liable. However, generally speaking, the employer is relieved from liability if the engineer exceeds his authority and affixes a signature or issues an order outside the scope of the employment.

In fact, there are many circumstances under which an engineer is personally liable for affixing his signature to contracts. For example, in the late case of Strauss V. Berman, 147 Atl. 85, it was disclosed that an employee, when intending to sign a contract for his employer, affixed his initials "L.B.," opposite the word "Approved" and signed his name "Louis Berman" after the words "Independent Corporation."

The corporation failed to meet the obligations of the contract and the other contracting party sued the employee on the contention that his signature affixed to the contract did not indicate conclusively that he was acting as agent for the corporation. Court held the employee personally liable.

Also, in another leading case, Gill V. General, 129 F. 350, it was shown that a seller submitted an offer to a firm named Gill and Company. The proposal was accepted by an employee who signed his name to the acceptance with the firm's partners. The seller sued to enforce the contract and although the employee was not a member of the firm the court held him liable, together with the partners.

In still another case, Ballon V. Talbot, 16 Mass. 461, it was disclosed that an employee signed a contract "Joseph Talbot, agent for David Perry,". In this case the court held the agent not liable, and explained the reason for the decision, saying:

"The important and effective word was not the word 'agent' nor the name of the principal, but the connecting word 'for' which was apt to express the fact that the act was done in behalf of the principal, in the same manner as if the words had been transposed thus: 'For David Perry, Joseph Talbot, agent' . . ."

Therefore, all engineers, in order to be relieved from liability on contracts, should sign as follows:

F. E. Stock Co. or *J. E. White,* Agent for,
By *J. E. White* F. E. Stock Co.
Agent or Engineer

On the other hand, the mere fact that an engineer signs a contract as "agent" is not sufficient to relieve him from liability. For example, in still another case, Campbell V. Porter, 61 N. Y. S. 712, the litigation involved a contract signed "John A. Porter, Agent." In this instance the court explained that where a person signs a contract or other paper, by affixing his own name, with simply the word "agent" added, such a contract is the signer's own for which he is personally responsible.

Under all circumstances an engineer is personally liable if he exceeds his authority. For example, in the leading case, Kroeg V. Pitcairn, 101 Pa. 311, it was shown that an agent exceeded his authority when making a contract. In holding the agent liable, the court said:

"The reason why an agent is liable in damages to the person with whom he contracts when he exceeds his authority, is that the party dealing with him is deprived of any remedy upon the contract against the principal, is not his in fact, and it is but just and fair that the loss occasioned by there being no valid contract should be borne by the agent who contracted for him without authority."

FUEL for HIGH-SPEED DIESELS

*By G. C. Wilson**

University of Wisconsin

TABLE I shows how limits of some actual diesel fuel specifications compare with the classification offered by Committee 6-2, A.S.T.M. Committees seem to agree that viscosity and ignition characteristics are the two most important properties. Viscosity is usually stated in Saybolt Universal seconds at 100 deg. F. It is important because of the need for lubricating the fuel pump and because increased drop size (which goes with increased viscosity) retards burning.

Bottom sediment and water maximum allowable per cent varies from nil to 1%. Smaller orifices in nozzles for open-type heads and smaller cylinder bores of the high-speed engine create a problem here. Filters have been only partially successful in removing fine material, which increases wear and partially clogs nozzles.

Pour point is important if engines are operated outdoors in cold weather. Some engine manufacturers state that pour point should be 10 to 15 deg. below minimum operating temperature.

Maximum allowable sulphur content is usually about 1 to 1.5%. If exhaust moisture is allowed to condense it causes corrosion, and sulphur is likely to be more of a problem for intermittent operation during cold weather.

Conradson-carbon tests show residual content of a fuel when distilled or burned with insufficient air. Such a specification undoubtedly limits the amount of heavy residual stock which may be put into a blend.

Ash is negligible in overhead distillates. This specification may be used to keep down the proportion of residual stock in the blend. Asphaltum content and neutralization number are considered to have little, if any, value. Flash point is included only to limit the fire hazard during storage and handling. Gravity alone means nothing, but with viscosity gives a measure of paraffinicity of an oil. Boiling range or volatility appears in only a small portion of available specifications.

Cetene number seems to be the most generally accepted unit for measuring ignition qualities. Cetene is used just as octane is in rating gasoline. Tests must be carried out on a specified engine under set conditions. Critical compression ratio must be determined on a C.F.R. engine modified to run as a diesel. The relation between C.C.R. and cetene number is given in Table II, the actual value varying slightly for different engines. Cetene number seems to be better, and runs about 33 to 75 for fuels from American crudes and 35 to 55 for gas oils from cracked stocks.

Diesel index number is calculated from aniline point and A.P.I. gravity at 60 deg. F. It is the product of the two divided by 100. Aniline point is the lowest F. temperature at which equal parts by volume of freshly distilled aniline and the test sample of oil are completely miscible. Diesel index can be determined in the field.

*An abstract of a paper, "Fuel Specifications for High-Speed Diesel Engines," before the Mid-Year Meeting of the American Petroleum Institute at Tulsa, Okla.

Table II—Approximate Conversion Chart for Diesel-Fuel Ignition Ratings

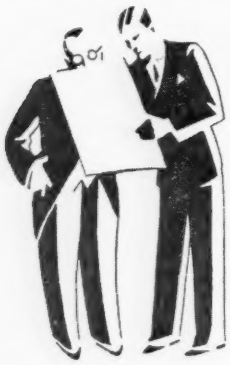
Cetene No.	C. C. R.	Diesel Index	Heptane No.	Remarks
30	12.0	..	33	
35	11.0	11	41	Rough
40	10.0	18	56	O.K. in
45	9.1	27	85	high-speed
50	8.5	35	100	Good fuel
55	8.2	42	...	
60	7.9	46	...	Noisy at
65	7.7	53	...	light loads
70	7.6	56	...	
75	7.4	59	...	

Table I—Typical Diesel-Fuel Specifications—1935

	Over 1,000 R.P.M.		Under 1,000 R.P.M.					
	ASTM 1-D	12 Mfrs.	ASTM 3-D, Over 360 R.P.M.	5 Mfrs.	5 Refiners	5 Railroads	Navy	ASTM 4-D, Under 400 R.P.M.
Gravity, deg. API	.....	24–36	.....	30–70	28–36	28	....	....
Viscosity, Sayb. Univ., at 100 deg. F., sec. (min.)	32–50	30–100	32–70	35–150	40–60	35–70	....	500 maximum
Pour point, deg. F. (max.)	35	0–30	35	0	0–15	0–35	0	35
Carbon residue, per cent (max.)	0.2	1.0	0.5	0.5	0.05–1.25	0.5	0.5	3.0
Sulfur, per cent (max.)	....	0.5–2.0	.....	0.3–1.5	0.63–1.50	0.5–1.0	1.0	....
Asphaltum, per cent (max.)	.....	1.0	.....	0.3	.....	.....	0.5	....
Bottom sediment and water,% (max.)	0.05	nil.–1.0	0.20	Trace–1.0	0–0.5	0.1–0.3	0.05	0.6
Ash, % (max.)	0.01	0.02–0.05	0.02	0.05	Trace–0.05	0.05	0.01	0.04
Flash point, deg. F. (min.)	115	150	150	150–190	Open cup 150–260	150	150	150
Ignition Quality:								
Cetene No. (min.)	*50	50–60	*40	50	.....	52	....	*30
Diesel index (min.)	*45	37–47	*30	.....	.....	.....	....	*20
Critical-compression ratio	*81	.....	*8.8	.....	.....	.....	....	*9.8

ASTM fuel-oil classification, reference No. 15. * Suggested.

READERS' PROBLEMS



QUESTIONS for Our Readers

Cleaning Oil from Piping

Question 1

WE HAVE *recently modernized our plant, replacing old steam engines with turbines. The steam engines exhausted against back-pressure to process, but the condensate was not used for boiler feed because of oil carried over in the engine exhaust. The new turbines also exhaust to process through the old piping system, and we find we are still unable to use the condensate because of oil that has collected in the old exhaust lines. Is there any way that we can clean out this piping so that we may use the returns for boiler feed and so greatly reduce our makeup water, which is now running about 60%?*—G.S.R.

When to Renew Rope on Hoists and Elevators

Question 2

WE HAVE *several hoists and elevators in our plant. After considerable discussion among our plant operators we have not arrived at a satisfactory answer to the question: How frequently should the ropes on these equipments be inspected? What is a reasonable length of service for these ropes? What is the best method for determining when the ropes should be renewed? Will some readers of* POWER *give us the benefit of their experience in solving these problems?*—K.B.T.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Professional Engineer's License

A FEW *days ago when I was in a Buffalo, (N.Y.) office, I noticed what appeared to be a license. If I remember correctly, it stated that the engineer concerned had satisfied the State of New York that he was competent to practice professional engineering. Is there a license law in New York State covering professional engineers? If so, what qualifications are necessary? The example mentioned was that of an electrical engineer, but there was nothing on the certificate to indicate what branch of engineering it covered. I would also like to know just what the definition would be in order to come under such a ruling.*—W.D.P.

Since 1920 in the State of New York it has been unlawful for any person to practice professional engineering or land surveying or to use the designation "engineer" in such manner as to convey the impression that he is a professional engineer unless duly licensed under the provisions of the education law. Section 1449 of the education law gives this definition: "A person practices professional engineering, within the meaning and intent of this article, who holds himself out as able to perform, or who does perform, any professional service, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any public or private utilities, structures, building, machines, equipment, processes, works, or projects, wherein the safeguarding of life, health or property is concerned or involved, when such professional service requires the application of engineering principles and data."

This applies to engineers working as employees for a salary as well as to those engaged in private practice for a fee. Employees working under the direction of a licensed professional engineer are exempted provided their work does not include responsible charge of design or responsible supervision. No corporation may engage in engineering work unless its chief executive, all employees doing responsible engineering work, and all employees designated as "engineers," are licensed professional engineers.

An applicant for license must be more than 25 years old, a citizen (or first papers), a graduate of an approved 4-year high-school course or the equivalent, and have eight or more years of practical experience in professional engineering work of a grade and character satisfactory to the State Board of Examiners for Licensing Professional Engineers and Land Surveyors. Graduation from an approved college of engineering is credited in lieu of four years of experience. The license fee is $25 for the first year and $1 per year for renewal.

Practically all candidates are required to pass a written examination to determine their ability to plan, structurally design and supervise the construction of buildings and similar structures. The candidate is required to take this structural examination even if his engineering work deals only with chemicals or radio receivers. If the candidate is not an engineering graduate, additional examinations are required in other subjects. These additional examinations will become mandatory in a year or two, so that it will become progressively more difficult to get a professional engineer's license in New York.

Similar laws have already been enacted in 34 states, and various state associations of professional engineers, as well as a national association, are promoting their passage.

It is suggested that all operating engineers and power engineers in industry, while interested primarily in operating rather than professional licenses, inform themselves on the provisions of these professional license laws, so as to comply with their requirements insofar as their work as power engineers or their use of the designation "engineer" may be affected.

HOW TO KEEP CONDENSATE OUT OF CONDUITS

ANSWERS to August Question No. 1

The Question

WE HAVE *experienced trouble with water in long power circuit conduits on gravel roofs. The water seems to be due to condensation. Days are commonly warm and bright, with cold, damp nights. Two remedies have been proposed. One is to drill ¼-in. holes at all low points, particularly in conduit fittings. These holes will serve as drains, and it is claimed they will also reduce condensation. The other method is to seal the conduit ends with insulating compound to prevent breathing that now can occur. These conduits are watertight, therefore rain cannot enter. Probably some* POWER *readers have solved such problems and will give others the benefit of their experience.*—R.B.G.

Permits Free Air Circulation

SEVERAL years ago, we experienced a similar condition in a lighting circuit on one of our dryers. Due to the high temperature difference between the inside and the outside of the dryer, some condensation was expected and the conduit system was made as airtight as possible. Standard electrical fittings are not adapted to hold against vacuum which takes place during the cooling-down period, and the conduit filled with water in a short time.

We then drilled a small drain hole in the lowest fitting and a continuous dripping could be observed. Under these conditions the insulation, which could not be rubber on account of the high temperature, failed in a short time. The whole system was rewired and all condulet covers on the outside of the machine were left off to allow free air circulation through the conduits. For the last two years we have not experienced any trouble whatsoever, the air circulation avoiding condensation.

Paterson, N. J. F. C. RAGG

Uses Battery Compound to Seal Conduits

I DO NOT believe that drilling holes in the conduit will help, other than rid the conduit of water. The conduit and wiring will still be damp. If the conduit runs across a roof from and to places cooler than the roof, then when the sun is shining any openings in the conduit will increase air circulation and condensation in the conduit. At night when it is warm in the building and cool outside, air circulation will be reversed in the conduit and cause more condensation.

The best method is to seal the conduit against the entrance of air. On several occasions I have used a compound that battery-repair men use (for sealing tops of automobile batteries) to seal the wires in the ends of conduits. This material is tough and does not get brittle and fall out due to movement of the wires. Before putting in the compound I pack around the wires with cotton waste or oakum. This prevents compound from running back into the conduit and making removal difficult. If possible melt the compound and pour about 0.5-in. layer into the conduit. If the conduit ends are horizontal, warm the compound and pack it in, using a pointing trowel.

Clarksville, Tenn. ZANZIE EDWARDS

Recommends Using Lead-Covered Wire

WHILE both the methods suggested to eliminate moisture difficulty within conduits would undoubtedly offer some measure of relief, complications might develop which aggravate conditions. Drilling drain holes in the conduits in the lowest sections would carry away the condensate but it would also subject the conductors to other equally objectionable hazards such as corrosive fumes, etc. Sealing the conduits could give rise to overheating of the conductors particularly if they are loaded to capacity.

I believe the most logical and satisfactory solution to this difficulty (higher in first cost than the suggested remedies but it will prove more economical in the long run) is indicated in Article 5, Section 503, Paragraph p of the National Electrical Code. This section states that "for conduit wiring installed . . . in permanently moist locations where subject to condensation of moisture, the conductors shall be of the lead covered type . . ."

Kingsport, Tenn. B. E. LINGAR

Seal Conduits With Insulating Compound

THE trouble R.B.G. mentions is not uncommon under such circumstances. However, drilling holes in the conduits and fittings is not the proper method to correct the trouble. As the moisture is condensed from the atmosphere, the more openings in the conduit the more the air which will enter, and the more the moisture which will condense.

These conduits should be sealed with insulating compound. Make sure that all joints are tight. At some time when the air is dry, such as late in the afternoon on a hot, dry day, carefully seal the conduit ends with compound. Make sure that the compound bonds onto the conduit. Warming the conduit will help, being careful not to heat it more than can be borne by the hand. This practice will exclude air that might enter the conduit at night or on wet days and condense. I have remedied trouble due to moisture in this manner in several installations.

Delevan, N. Y. WILLARD D. PRATT

Opposes Drilling Holes in the Conduit

I WOULD suggest that R.B.G. seal all joints in the conduit against moisture, paying particular attention to the condulet fittings. Then thoroughly seal the conduit ends with insulating compound. Where wires leave the conduit at fittings exposed to the weather, provide proper drop loops on them to prevent water flowing back into the conduit.

Drilling holes in the conduit as suggested would be dangerous and should not be attempted. Even if the wires were pulled out of the conduit before drilling the holes, the rough edges caused by the drilling probably could not be all removed and might damage the insulation when the wires are replaced. The holes would also expose sections of the insulation to the elements in the air and cause early failure.

Waynesboro, Va. J. M. MYERS

WATER FOR SLUICING ASH

ANSWERS to August Question No. 2

The Question

ASH *from our pulverized-coal-fired boilers is sluiced out to a pit. The centrifugal pump which supplies sluicing water is driven at constant speed by a squirrel-cage motor and has a rated capacity of 600 g.p.m. at 250-ft. head. It has seemed to us that more water is being used for sluicing than necessary. As the pump is driven by a constant-speed motor, we can reduce the discharge only by throttling either the discharge or suction of the pump. Will this reduce power required by the pump? If so, will we get a greater reduction by throttling the suction or the discharge?* —G.P.S.

Turn Down Impeller Diameter

GOOD engineering practice requires that the delivery of a centrifugal pump be regulated by throttling the discharge valve. Never run a centrifugal pump with a throttled suction, as a partial vacuum is set up in the pump casing which is liable to damage the seal rings and other running parts that depend on water for their lubrication. There is also a tendency towards cavitation or pitting of the impeller, due to the fact that it is running only partially submerged.

Decreasing the rate of discharge can also be accomplished by turning down the size of the impeller by taking a cut off the rim. This should not be done, however, without first securing the necessary data and the manufacturer's advice on the problem. I recommend it only as a last resort, since the pump could never again be used at its original rating.

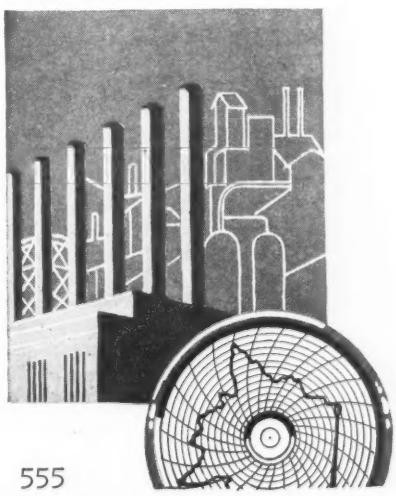
While regulating the rate of flow by throttling the discharge valve is somewhat inefficient, it is commonly resorted to, as it is the easiest solution to the problem. Since G.P.S. fails to give the pump and motor characteristics, it is difficult to say just how much this method would affect the power required by the motor. Shut-off pressure (throttled discharge) usually runs between 10 to 15% greater than when running at rated discharge. However, it would appear that, unless you are now using an amount of water far in excess of that necessary, you will not be obliged to cut down your discharge to the point where the efficiency and economy of your motor will be affected. No damage can result to either pump or motor by running throttled, unless the pump casing should heat up, due to impeller friction. Here again, the possibility is remote, unless you are obliged to throttle down too much.

Vero Beach, Fla. HOMER D. WHITE

Install New Impeller

THE problem of controlling the discharge of a centrifugal pump without benefit of a variable-speed motor presents few difficulties once the particular problem on hand has been analyzed. The main object in this particular case being to reduce power consumption, two solutions present themselves, the choice between the two depending on whether a permanent or a temporary reduction of capacity is indicated.

In case a temporary reduction is desired, the pump should be throttled in the discharge to get the benefit of maximum power reduction. The reason for throttling the discharge rather than the suction of the pump is that by throttling the latter pump efficiency will be seriously affected and that there arises the danger of operating the pump within the range of cavitation. This results in noisy operation, erosion of the impeller and general wear of pump parts. The power saved by throttling the discharge depends primarily on the shape of the power-



capacity curve, which, of course, is an inherent property of the pump installed.

A much better solution is available in case a permanent reduction of capacity is desirable. The pump manufacturer can supply his customer with a special impeller which will fit in this pump, and which will deliver a lower capacity against the same head, at approximately the same efficiency, the saving in power being, therefore, proportional to the reduction in capacity. The actual difference between this and the first solution lies in the fact that when throttling the losses in the throttling valve are not recoverable and do no useful work even though power is used to produce the full pressure at the pump, while in the case a new impeller is furnished, no throttling losses will occur.

Harrison, N. J. I. J. KARASSIK

Do Not Throttle Suction

THE suction valve of a centrifugal pump should not be throttled, as pump suction head should be as low as possible for best operation. With the discharge valve of the pump open and the valves to the sluicing jets open, the discharge head on the pump is greatly reduced, and, therefore, the maximum horsepower is required and a greater quantity of water is pumped.

A characteristic curve could be made up for the unit in question by testing it and varying the opening of the discharge valve, which would show the horsepower, head, gallons per minute, and efficiency from zero opening to maximum. No doubt the pump manufacturer could furnish such a chart on request. For example, a characteristic curve of a typical constant-speed centrifugal pump working against a 115-ft. head, pumping 600 g.p.m. shows 40 hp. required. When head was reduced to 95 ft., it pumped 1,800 g.p.m. and required 60 hp. Thus it is seen, the reduction in head greatly affects the amount of water and the horsepower.

In sluicing ashes from a pulverized-coal unit, a strong jet of water is more important than a great quantity, therefore I would suggest closing off all of the sluice jets except those necessary on the boiler being sluiced and throttle the jet valves rather than the pump discharge valve. This would decrease the horsepower, give a higher pressure at the jets, and reduce the amount of water necessary for sluicing.

Waynesboro, Va. J. M. MYERS

Throttling Decreases Pump Efficiency

IN THROTTLING a centrifugal pump, the throttling valve should be in the discharge line. Under no circumstances would I recommend throttling the suction line.

There are too many factors to be considered to allow a definite answer as to the amount the power consumption will be reduced by a given amount of throttling. If the pump is properly designed and running at its rated speed and head, throttling of any magnitude will reduce the efficiency, inasmuch as the mechanical losses of the pump are substantially the same whether it is delivering the maximum volume of water or is completely throttled. If the mechanical loss is 5% at full delivery, and the discharge was throttled one-half, the mechanical losses will remain the same, while only half the water will be pumped. This would make the losses equal to 10%. There will be some additional losses due to hydraulic shock if the pump is throttled considerably, as this disturbs the proper relationship between the speed of the pump rotor and the rate of water flow through it.

Despite these losses, power consumption of the pump should decrease as the discharge is throttled. If the pump is working against maximum head, power consumption will decrease approximately as water flow decreases. However, if the pump is working at low head, the pressure will build up somewhat, so that the power consumption will not drop as rapidly with a decrease in volume of water delivered. This will be readily understood when it is considered that the power required to drive a pump depends on the volume of water handled and the head or pressure pumped against. The best way to determine the amount of power saved would be to insert a wattmeter in the motor circuit and observe it while throttling the discharge the desired amount. If the voltage regulation is good on the circuit, an ammeter in the circuit will give a good approximation of the power saving.

Delevan, N. Y. WILLARD D. PRATT

Power Saved by Throttling Depends on Characteristic

THE characteristic curves of most general-service centrifugal pumps show a decrease in brake horsepower with a decrease in rate of flow. Pumps having a so-called "steep characteristic" to secure a lower variation in discharge with an increase in head show an increase in horsepower with a decrease in rate of flow up to a certain point. Beyond this point, the b.hp. gradually falls off. Thus it is seen that reference to the characteristic curves of the pump in question is necessary for a clear solution to this problem. Pump manufacturers are always willing to supply these.

Theoretically, there is no difference in power reduction produced by throttling the suction or discharge to secure a given rate of flow. All that throttling does is to increase the friction and velocity heads in order to make the total head correspond to the discharge desired. The discharge and total head remaining constant, the power to drive the pump remains constant as is evident from the equation for power:

$$P = \frac{W H_t}{550}$$

where P = horsepower to drive pump.
W = rate of flow, lb. per sec.
H_t = total head, feet. (The summation of static, velocity, and friction heads.)

However, throttling the discharge is the more usual method of regulating the flow of constant-speed pumps.

Throttling the suction on installations having suction lift creates so great an increase in friction head that the suction pressure is insufficient to raise the water to the pump level, or the suction pressure is reduced to the vaporization pressure of the water and the pump becomes vapor-bound.

If desired rate of flow is much less than the rated discharge, it would be advisable to look into the possible economy which may be secured by reducing the pump speed by the use of another motor.

New York, N. Y. MILTON N. KRAUS

Throttling Discharge Saves Power

IT IS a common characteristic of centrifugal pumps operating at constant speed that a reduction in output decreases the power consumption. If the reduction is to be by throttling the throttle should be placed on a discharge side, because if it is placed on the suction it may have an unfavorable effect on keeping the packing tight.

As there is a great difference in the characteristics of pumps of different manufacturers no arbitrary rule can be given by which it can be accurately calculated how much power requirements will be reduced by a stated reduction in the capacity. A safe method of procedure would be to determine the actual quantity of water required and then take up the question of efficiency with the manufacturer of the pump.

Throttling may be the correct answer but it is also quite likely that a reduction in the size of the impellers or new impellers may be a better solution from an economic standpoint, provided the reduction in capacity amounts to much.

Florence, Ky. IRA A. BUTCHER

FOREIGN BOOKS

LE MACCHINE TERMICHE (1935). *By Mario Medici, Professor at the Engineering Institute of Padova, published by Casa Editrice Dottor Antonio Milani, Padua, Italy. Cloth, 9x6½ in., 210 pp., 160 illustrations, price not stated.*—This text, written in Italian, treats of combustion, boilers, fuel firing equipment, condenser and condenser auxiliaries.

WÄRMETECHNISCHE ARBEITMAPPE *(Worksheets on Heat Technology). Published by VDI-Verlag G.m.b.H., Berlin. Price 4.80 Reichsmarks.*—During the past few years the publication "Archives for Heat and Steam Boiler Technology" has scored up the results of various tests and researches in the form of charts for convenient reference. 46 such charts have been assembled in a packet.

DIE DAMPFTURBINE IM BETRIEBE (1935). *By Dr. Ing. E. A. Kraft, Director A.E.G.-Turbinenfabrik. Published by Julius Springer, Berlin, Germany. 277 pages, 10½x7 in. Cloth. Price 37.5 Reichsmarks.*—Written in German, this treatise discusses phases of turbine engineering not often found in texts. It is divided into three main chapters, dealing with turbine erection, turbine operation and turbine troubles respectively. Well illustrated.

REGELN FUR ABNAHMEVERSUCHE AN DAMPFTURBINEN *(Rules for Steam Turbine Tests). Published by VDI-Verlag G.m.b.H., Berlin. Price 1.50 Reichsmarks.*—This ten-page pamphlet constitutes a second, revised edition of rules published by the VDI two years ago. Symbols, units and formulas are explained.

THE ENGINEER'S BOOKSHELF

Coal

KEYSTONE COAL BUYERS MANUAL (1935).—*Edited by Sydney A. Hale. Published by McGraw-Hill Publishing Co., Inc., Catalog & Directory Division, 330 West 42nd St., New York, N. Y. Cloth-board covers. 458 pages. 8½ x 11½ in. Numerous maps, tables and illustrations. Price, $10.*

Extremely detailed and comprehensive, devoted entirely to practical information on a subject of great importance to power engineers, this book deserves more than a perfunctory notice. While there was a 1932 edition of the Keystone Coal Buyers Manual, the present edition is in reality an entirely new book, revised and checked from start to finish, rearranged and with much new material. The book was conceived, planned and executed by Sydney A. Hale, Editor of Coal Age, working with a staff of recognized authorities. Seventeen pages of fine types are devoted to an alphabetical index of mines and companies. Coal sales agents are also indexed. Sections following cover: coal fields of the United States (with fullspread map); classification of coals by rank, by use (including extensive comments on industrial coals, size of stoker equipment, powdered coal) and by physical structure; composition of coal (reviewing also the formulas and calculations so frequently used by all power engineers); bituminous coal preparation; coal selection in the eastern states; geographical differences in coal selection; steam plant characteristics and their influence on coal selection; the use of a laboratory in coal selection (with detailed instructions for sampling); coal-buying in the middle and western states; district selling agencies.

Following this we find 352 pages taking up the coal-producing states, one at a time, in alphabetical order. Each of these state sections discusses the general coal geology of the state, defines the mining districts, lists the important coal seams and locates them on a map of the state. For each coal seam tables gives the range (as determined by official analysis) of the proximate analysis constituents. Finally, each state section gives an alphabetical directory of the coal mining companies in the state, with detailed information covering each mine. The companies are indexed by seams also.

From this summary of contents, it will be evident that the Keystone Coal Buyers Manual is devoted mainly to highly detailed practical information, rather than to generalities, so that each buyer may get down to the "brass tacks" of the coals from which he must select to produce steam reliably at the lowest overall cost.

Among the practical data given for this purpose are the general uses for which coals in each district are available, the sizes commonly shipped and the railroads serving the given fields.

Not counting railroads, the yearly consumption of coal by the manufacturing plants and public utilities of this country is around 150 million tons, with an aggregate delivered value exceeding six hundred million dollars. When it is remembered that by far the largest part of this fuel is used for steam generation, and is selected by power engineers, the importance of a book of this sort to power engineers can be appreciated.

Diesels

DIESEL ENGINES (1935)—*By J. W. Anderson. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 491 pages, 6 x 9 in. 284 illustrations; many tables. Cloth. Price $5.*

If you want to know about the diesel today, this is the book. Everything from Dr. Diesel's first patent to the newest radial and crankless types is included, plus illustrations and descriptions of practically all current types. The author has gone even further and classified current engines in seven groups, showing identifying characteristics of each group and giving some comparative data. These groups are: automotive, mobile-machinery, marine, stationary, railway, oil-country, and aviation.

Treatment is without the furbelows and extensive theorizing of earlier texts. The whole chapter on theory, in fact, covers only 13 pages. Planned for the operating man, this whole book is essentially practical, and tells concisely what diesels are, what they do, and how to pick one to suit a particular job. Installation, operation and maintenance also find a place.

Engine details are discussed in these chapters: Design Characteristics; Scavenging, Charging and Supercharging; Combustion Chambers; Fuel-Injection Systems; Design Details; Governors, Control and Safety Equipment; Cooling and Cooling Water Systems; Lubrication and Lubricating Systems; Fuels and Fuel Systems; Starting Systems; Waste-Heat Utilization. There's a chapter on installation, one on operation and maintenance, one on cost and performance, one on selection.

This reviewer has talked with Mr. Anderson, diesel engineer of 20 years standing, many times during preparation of the book, so any serious criticisms have been talked out before publication. All along, we have been impressed with the thoroughness and accuracy of the author and his sincere effort to produce a practical working handbook without ballyhoo and with every statement supported by facts and experience.

Generating Stations

GENERATING STATIONS *(Economic Elements of Electrical Design) (2nd Edition)—By Alfred H. Lovell, prof. of Elec. Power Engrg., Univ. of Mich. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 438 pages, 6 x 9 in. Cloth. 203 illustrations. Price $4.50.*

Distinctly a college text, this volume nevertheless is a convenient "brush-up manual" for the utility electrical engineer. It covers all elements of public utility power plants from financing and investment to maintenance, dealing in all cases with costs as well as theory and practice. Its eleven chapters include: Elementary Principles of Corporation Finance, Cost of Stations, Economic Decay, Power Plant Load Curves, Power Distribution Systems, Power Plant Location, Bus Systems and Current-Limiting Reactors, Oil Circuit Breakers and Their Applications, Transmission Lines with Synchronous Condensers.

This rewritten edition has taken into account such data as development of the mercury-steam cycle, steam turbines, Federal hydro projects, the diesel, higher voltage for long-distance transmission, circuit breakers, high-speed relays, etc., plus additional information on the more-than-ever accented factors of economic life, distribution costs, engineering design, and rehabilitation and improvement of old stations.

Heating and Air Conditioning

HEATING AND AIR CONDITIONING (4th edition)—*By John R. Allen and James H. Walker, with a chapter on Hot-water Heating by F. E. Giesecke. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 444 pages, 9 x 6 in. Cloth. Illustrated. Price $4.*

This is the fourth edition of the well-known text, "Heating and Ventilating." It has been revised to include the most recent advances in heating and particularly in air conditioning. Several of the chapters, such as those on hot-air and hot-water heating systems, have been condensed, and heat and properties of steam have been combined into one chapter. This makes it possible to add material on air conditioning and control without materially increasing the size of the book.

Brief Reviews

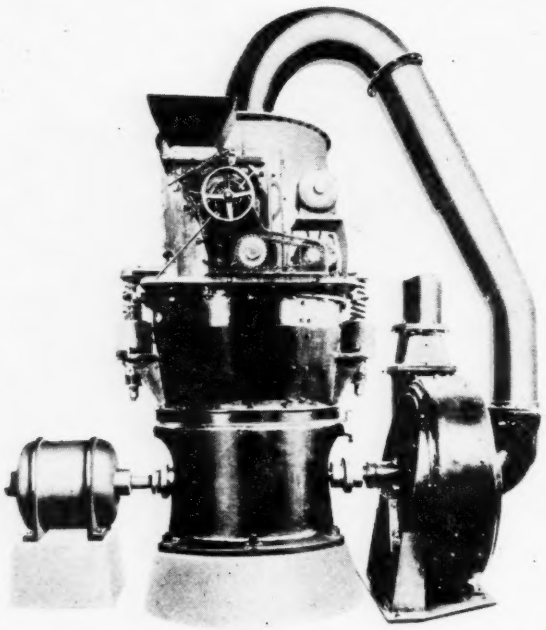
POCKET MANUAL OF MEGGER PRACTICE (1935). *Published by James G. Biddle Co., 1211 Arch St., Philadelphia, Pa. 128 pages, 4¼x7¾ in., paper.*—While this new manual does not render obsolete the previous editions bearing a similar title (dating back as far as 1923), it is intended to amplify the subject of insulation testing.

MAPS OF COAL DISTRICTS IN S. E. OKLAHOMA (1935)—*Published by Department of Interior. Copies from Director, U. S. Geological Survey, Washington, D. C. Price, $1 per copy, or $4 for full set of five maps. Also* REPORT OF INVESTIGATION IN 1934 ON GEOLOGY AND COAL RESOURCES OF MINOT AREA, NORTH DAKOTA. *By U. S. Geological Survey.*

UNITED STATES DIESEL ENGINEERING SCHOOL CATALOG (1935). *Paper, 27 pages.—Personnel, description of "courses and other general information.*

STATE GEOLOGICAL SURVEY, URBANA, ILL.—*Three reports of investigations in Illinois. Price to non-residents of Illinois, 25 cents each. No. 33, Mineral Matter of No. 6 Bed Coal at West Frankfort, Franklin County, Ill. No. 37, Briquetting Illinois Coals Without a Binder by Impact. Report, No. 38, Approximate Analysis and Screen Tests of Coal Mine Screenings Produced in Illinois.*

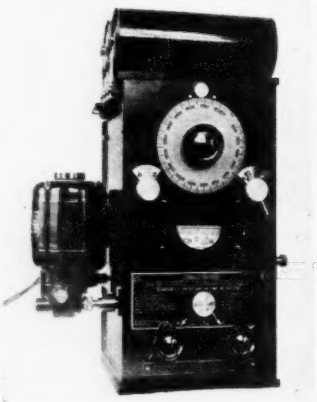
WHAT'S NEW IN PLANT EQUIPMENT



BALL MILL PULVERIZER

COAL ground between reduction rolls and grinding ring works up walls of revolving bowl, or grinding chamber, due to centrifugal force, and fines and intermediate sizes are picked up by air current from annular spaces around bowl and carried into separator above for further classification. Rolls are held in fixed position by heavy journal heads supported on trunnions resting on top plate of mill. Clearance between rolls and revolving bowl adjusted from outside, while mill is running. Journal heads connected through arms to roll pressure springs and adjustment rods mounted in cast-iron lugs outside casing. By adjusting these compression springs, grinding pressure can be controlled while mill is running. Bowl revolves on vertical shaft mounted on roller bearings and driven through worm gear by horizontal main shaft direct connected to constant-speed standard motor. Pressure spring allows ungrindable material to pass rolls without injury, thence to top of bowl into annular space below, from which it is expelled by revolving plows. Equipped with air separator and automatic feeder mounted on top plate for cold grinding and firing. Adapted to both direct-firing and storage systems.

Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y.



MOTOR FOR PYROMETERS

MOTOR, Type H, for installations where Foxboro potentiometer control pyrometers are used singly, comprises a ball-bearing inclosed motor and double worm-and-gear speed-reducing system packed in lubricant. Also able to operate one additional controller through coupling between controllers. Bulletin 202.

Foxboro Co., Foxboro, Mass.

WEATHERPROOF LINE WIRE

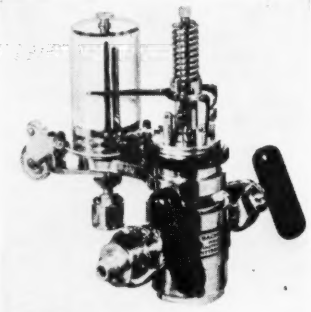
WEATHERPROOF line wire with varnished cambric and weatherproof braid treated with U.R.C. compound has solid or stranded copper conductors, depending on size. Has two wraps of 0.010-in. varnished cambric in size from No. 20 A.W.G. to 500,000 c.m., and three wraps from 600,000 to 2,000,000 c.m. Over-all covering is heavy cotton braid treated with high melting point weatherproof compound.

General Electric Co., Schenectady, N. Y.

PRESSURE RECORDER

PISTON-TYPE differential pressure recorder for rapidly fluctuating pressures. Similar to an engine indicator, recorder consists essentially of cylinder with lapped piston, helical spring opposing piston movement and recording drum. Clockworks available to give chart speeds of from 7 to 72 in. per min., 10 to 100 ft. per min., 150 to 450 ft. per min. Within speed range, clock may be set for four intermediate speeds. Unit pressures acting against each piston side are equal and spring is calibrated so that load deflection rate is directly proportional to difference in pressure above and below piston. Piston movement is transmitted to recording pointer by straight-line mechanism producing magnification of six times. Maximum standard range is 2,000 lb. per sq.in., with higher ranges by special construction.

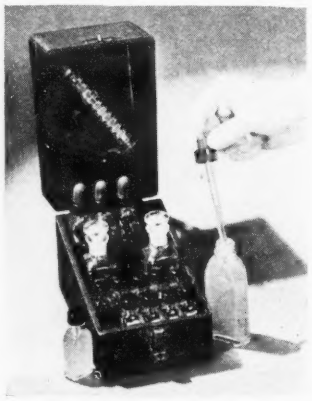
Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.



PIPE WRENCH

REMOVABLE lower jaw of hardened steel with cross tongues seating into cross slots in handle is locked in place so as to eliminate backward shear on pin and prevent loosening in service. Drop-forged steel with housing forged integral with handle, and heat-treated, this wrench has "Parkerized" rust-proof finish and cadmium-plated nut.

Walworth Co., 60 East 42d St., New York, N. Y.



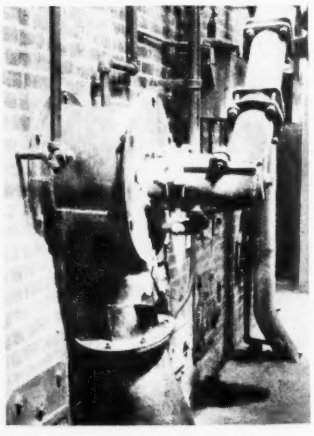
COLORIMETRIC TESTING KITS

EQUIPMENT used for testing for silica, phosphate, oxygen and pH are contained in small leather cases. Solutions are contained in small pipette stoppered bottles, eliminating need for extra measuring graduates or pipettes. Extra solutions with each kit. Separate cases required for oxygen or pH, while silica and phosphate kits may be combined. Cases $5\frac{3}{4}$ x $4\frac{1}{2}$ x $7\frac{1}{4}$ in. with handle on top.

National Aluminate Corp., 6215 West 66th Place, Chicago, Ill.

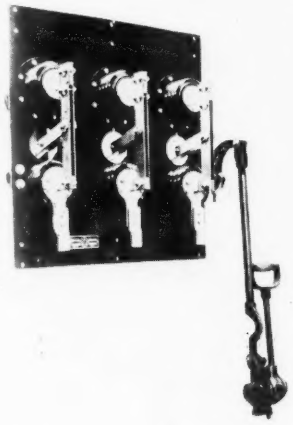
CINDER BURNER

"STEAMATIC" cinder burner consists of self-feeding intakes with fully-inclosed valves for connection to soot and cinder hoppers, transport line, and vacuum producer located at end of line discharging into furnace and burner for supplying and mixing of auxiliary air. Vacuum producer consists of series of Monel metal



nozzles cast in annular ring of "Durite" iron and directed through "Durite" Venturi tube. Exhauster creates flow of air through transport line to draw material from hoppers and discharge into furnace. Use of self-feeding intake regulates capacity in proportion to amount of air flowing through transport line. Exhauster operated either by steam or compressed air. Steam consumption is about 200 to 300 lb. per ton of material conveyed.

United Conveyor Corp., Old Colony Bldg., Chicago, Ill.



DISCONNECT SWITCHES

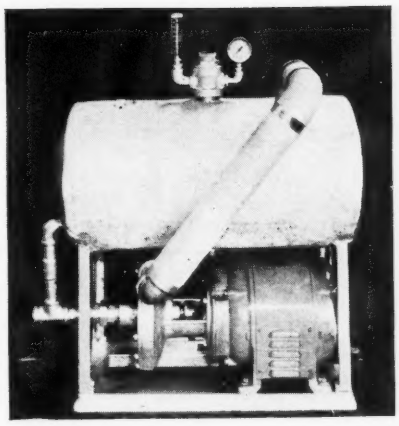
THREE-POLE, indoor disconnecting switches with tongue-type contacts, double blades and operating mechanism which can be locked in either open or closed position. Type "3CJH-34," 7.5 kv., 400-amp. switch pictured, top insulator is of back connected bushing type, lower, front connected. Steel base arranged for flat or pipe mounting. Connecting rod between switch mechanism and operating handle can be of any length.

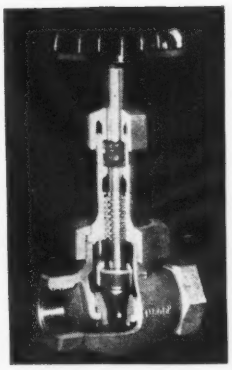
Delta Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.

CENTRIFUGAL PUMP

"BLACK ARROW" single-stage centrifugal pumps in sizes from 2 to 14 in. for capacities from 30 to 10,000 g.p.m. and for heads up to 300 ft., is of double-suction, horizontal split-casing type. Bulletin D-17.

Lawrence Pump & Engine Co., P. O. Box 70, Lawrence, Mass.





STEAM RETURN SYSTEM

CONSTANT circulation flowing through vacuum chamber creates suction on return line and develops necessary pressure to overcome boiler pressure in this condensation and steam return system. Water in circulating tanks flows into line pump, discharges through vacuum chamber into pipe line in rear of tank and back into tank. Return condensate enters through vacuum chamber discharges into line in rear of tank, mixes with the circulating water and goes back into tank. Tank being full, excess is forced directly to boiler.

Becker Pump Co., 463 Second St., Oakland, Calif.

UNIVERSAL OSCILLOGRAPH

VARIETY of interchangeable control panels permit this unit to fit field or industrial and laboratory investigations and provide a wide selection of galvanometers for producing up to eight records. Type PA unit offers simultaneous viewing of phenomena while photographing. Oscillograph with controls exclusive of film-holder measures 25x8½x9½ in., and weighs about 50 lb.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BONNET GLOBE VALVE

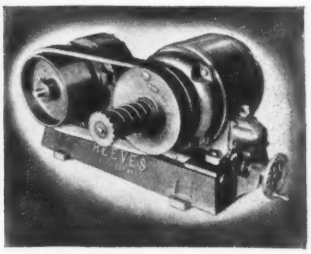
UNION bonnet bronze globe valve has stainless steel valve disk and seat rings, with surfaces hardened to 500 Brinell, said to prevent wire drawing, steam cutting and galling. Disk attached to stem to insure correct seating and facilitate regrinding. Design provides tight back-seating and permits easy repacking while valve is in pressure service. Made for steam pressures up to 300 lb. Available in both globe and angle patterns.

Hancock Valve Co., 75 Elias St., Bridgeport, Conn.

SMALL-MOTOR TEMPERATURE INDICATOR

DEVICE called "Ideal Tel-Temp" for determining temperature in open and closed small motors, bearings, air compressors, centrifugal pumps, etc., employs bimetallic principle and consists of dial plate mounted in dustproof aluminum case protected by nonbreakable crystal and chromium-plated cap. Temperature readings from 0 to 100 deg. C. Base has threaded stud that screws into case, and is attached to machine frame with escutcheon pins. Case has a flexible rubber ring that fits tightly against the machine, keeping drafts and outside temperature fluctuations from affecting true temperature of machine being tested.

Ideal Commutator Dresser Co., 1813 Park Ave., Sycamore, Ill.



MOUNTING FOR SPEED REDUCER

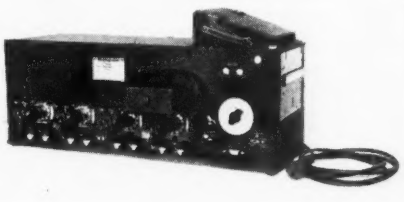
STANDARD mounting permits direct drive from vari-speed motor pulley to reducer. Adjustable base, bolted stationary base, replaces countershaft on motor pulley unit and holds gear reducer. For all standard-size motor pulley units.

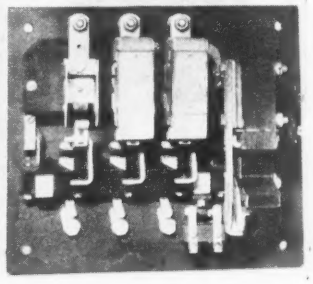
Reeves Pulley Co., Columbus, Ind.

CONTACTORS

100 and 150-amp. Westinghouse "De-ion" contactors provide rolling and sliding contact on closing with high contact pressure. Shields confine flame so that electrical clearance may be reduced. Thin layer of air adjacent to cold cathodes withstands about 250 volts before breaking down, and after having been subjected to arc, de-ionizes rapidly. When contact separates arc is forced into grid chamber and as current passes through zero point of cycle, air between plates is de-ionized and arc extinguished.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

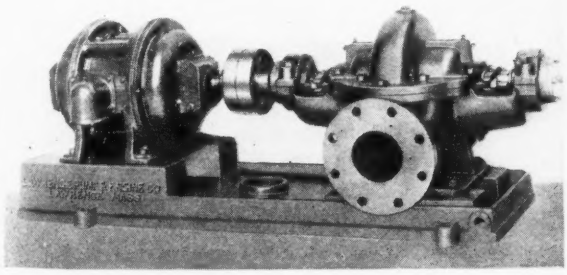


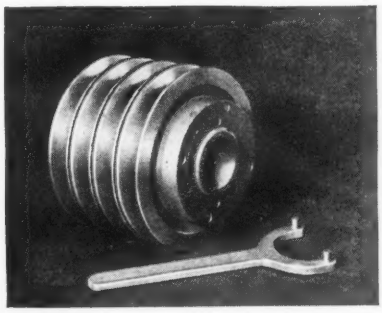


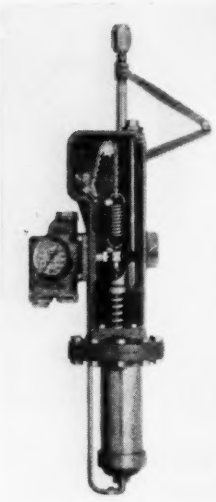
TEXROPE SHEAVE

PITCH diameter of "Vari-Pitch Texrope" sheave is adjustable to give speed variations up to 25%. Two multigroove types, stationary and motion controlled for occasional and frequent changes of speed.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.







SMALL UNIT FOR AIR-CONDITIONING

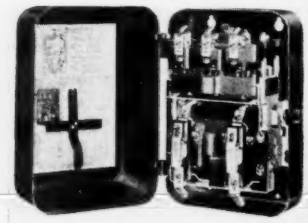
SELF-CONTAINED summer air-conditioning unit operates on 110-volt a.c., circulates 275 cu.ft. per min. Compressor, evaporator, air-cooled condenser, expansion valve, refrigerant (Freon) and oil are hermetically sealed at factory. Compressor unit mounted in frame at lower part of cabinet. Upper part houses fans, filters, control switches and window duct connection. Single motor drives two sets of fans. One set recirculates air from room, brings in outdoor air, sends mixed air through filters over evaporator coils to cool and dehumidify, then out into room. Second set of fans brings in outdoor air, filters, passes over condenser coils and drip pan which collects condensate from evaporators, and sends heated moisture-laden air outdoors. Manually controlled, interlocked to prevent incorrect operation. Type FC-2.

General Electric Co., Bloomfield, N. J.

MOTOR STARTER

TYPE A-32 across-the-line motor starter rated at 25 hp. at 440 and 550 volts, 15 hp. at 220 volts, and 7½ hp. at 110 volts, is furnished for remote control. Temperature overload relay is designed on melting alloy principle. Heavy silver contact, vertical make-and-break, short-stroke mechanism, and multi-break arc-prevention principle.

Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass.



CONTROLLERS

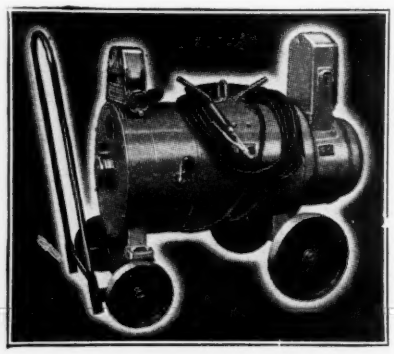
TYPE 100 series controllers are self-contained units comprising (1) actuating member, diaphragm or lever, (2) 4-way control valve which governs flow of water, oil or air to (3) a double-acting power cylinder built into unit; (4) built-in compensator, and (5) range adjustment. Actuating member may be a diaphragm with control pressure on one side, or on both sides, or lever moved by outside or remote means. Bulletin No. 963.

A. W. Cash Co., P. O. Box 135, Decatur, Ill.

ARC WELDER

"HEAVY DUTY" arc welder has oversize, 2-bearing armature shaft, removable ball-bearing capsules, more simplified single current control, dustproof calibration plate, heavy-duty built-in polarity switch, and drip-proof housings. Solid cast motor frames have top opening for terminal leads and mounting of magnetic switch-type starter. Equipped with pushbutton-operated no-voltage release and overload protection. Available for standard or special voltage of two- or three-phase, 60- or 50-cycle current. Also gasoline-powered units and stationary and portable mountings.

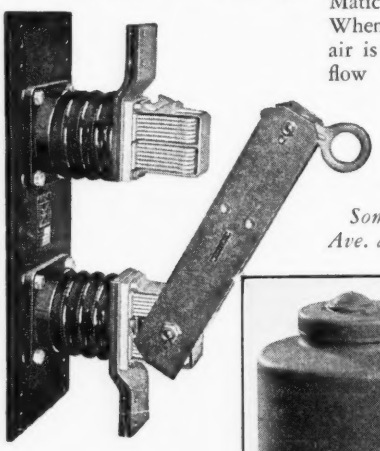
Harnischfeger Corp., Milwaukee, Wis.

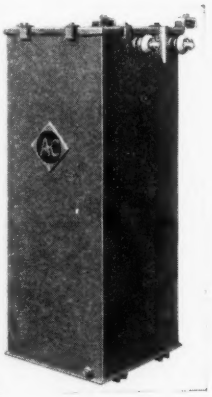


DISCONNECT SWITCHES

SOLID contacts are replaced by series of wire contact fingers with hard-drawn copper wires wedged into terminal block, in line of multiple-point contact disconnecting switches. Contact wire has rolled silver insert which makes silver-to-silver contact with inlaid silver ribbon in switch blade. High percentage of actual contact surface claimed.

Schweitzer & Conrad, Inc., 4435 Ravenswood Ave., Chicago.

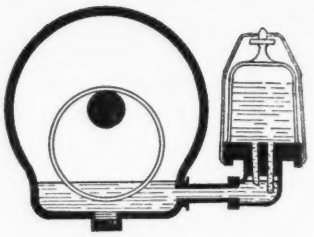




BRANCH FEEDER REGULATOR

TYPE BFR branch feeder regulator covers 10% range in eight 1¼% steps. Standard sizes from 5 to 200 amp., 2,400 to 13,200 volts in both single- and three-phase.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

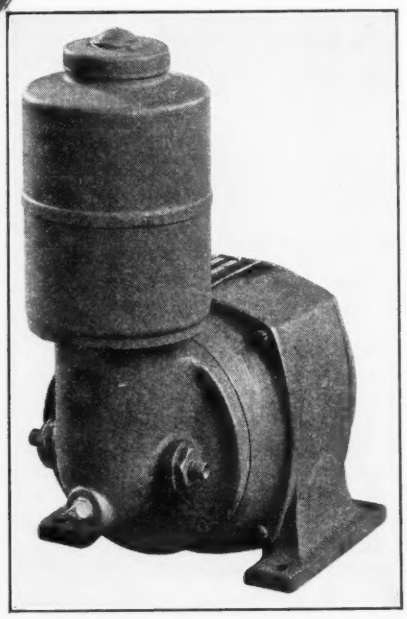


AUTOMATIC OILER

NO MOVING parts and visible oil supply are features of "Vis-O-Matic" constant oil level control. When oil falls below short tube, air is admitted and allows oil to flow through long tube until short tube is closed again.

Will not flood bearings nor soak motor windings because level is independent of oil supply.

Somerset Electric Co., Trenton Ave. and Somerset St., Phila., Pa.



LUBRICATION SYSTEM

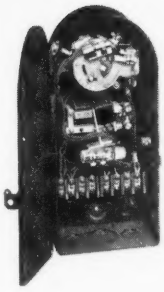
FULLY-INCLOSED pumping unit for Type "C" system contains only two moving parts. Piston displacement type of valves of different capacities located at bearings control delivery of lubricants to central pumping units by means of single line. Adjustable timer governs operation.

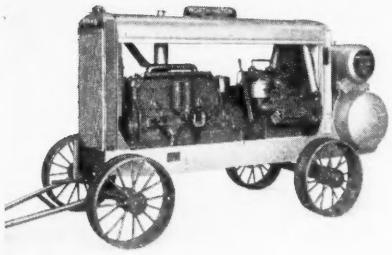
Farvall Corp., Cleveland, Ohio.

AIRLINE COUPLERS

FOR attaching and disconnecting airline equipment, such as grease guns, spray guns, air chucks, blow guns, chuck gages, etc., these cadmium-plated steel couplers contain a tripping deflator and replaceable rubber washer. May be interchanged at pipe or hose outlets. Check unit contains automatic shutoff parts.

A. Schrader's Son, 470 Vanderbilt Ave., Brooklyn, N. Y.





STOKER CONTROL SYSTEM

"STOKATHERM" (illustrated) operates in conjunction with "Sensatherm," boiler limit control, and "Pyratherm" in this stoker control system. Firing periods are regulated by "Stokatherm" and "Pyratherm" to maintain minimum fire when thermostat is in off position. System compensates for various burning rates and stops stoker if fire goes out or fuel is exhausted. "Stokatherm" consists of self-starting, synchronous motor starter and transformer relay with fixed, high voltage primary and movable secondary connected to low voltage thermostat circuit which controls mercury switch. Steel housing, 12 x 6½ x 3 3/16 in. is provided with knockouts in back. Bulletin No. 241.

Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.

GOGGLES

F3100 model substitutes pearl full-rocking nose-pads to distribute weight on sides rather than top of nose. Flexible cable earpieces are completely insulated. "Ful-Vue" goggle fitted with six-curve "super armorplate" lenses said to be capable of withstanding blows approximately twice as heavy as standard lenses. Domed surface to deflect glancing blows.

American Optical Co., Southbridge, Mass.

COMPRESSORS

2-STAGE air-cooled compressors, motor- or belt-driven, of case hardened alloy steel simplate valves; constant speed control; force feed lubrication; and full-floating piston pins. Twelve models, Bulletin No. 759.

Chicago Pneumatic Tool Co., 6 E. 44th St., New York, N. Y.

PORTABLE COMPRESSORS

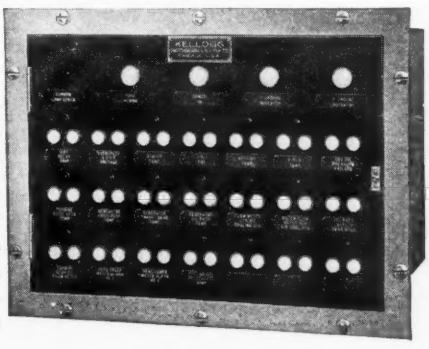
FOUR models of two-stage portable compressors for delivering 105, 160, 210 and 315 cu.ft. of air per minute are direct-connected to heavy-duty 6-cyl. gasoline engines. Equipped with "feather valves," ring-type cooling fins, articulated connecting rods, drop-forged crank shafts, spray and forced-feed lubrication, oil filter and V-belt-driven cooling fan, these compressors run at 830 r.p.m., and produce 100 lb. gage air pressure. Variety of mountings available.

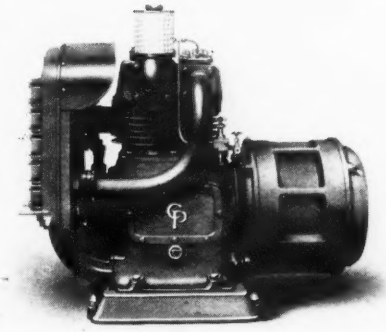
Worthington Pump & Machinery Co., Harrison, N. J.

ANNUNCIATOR UNIT

ASSEMBLED in steel cabinet, self-contained as illustrated, or designed to fit into existing gage or control board, these annunciators have provisions for operation on either continuous or momentary alarm contacts, with manual, automatic or remote lamp-reset features. Audible alarms, holding lamps, and operation counters are also available. Each circuit marked with nameplate at panel to designate associated machine or apparatus.

Kellogg Switchboard & Supply Co., 106 West Adams St., Chicago, Ill.





LOW-PRESSURE FLOW METER

FOR measuring low-pressure liquids and gases which will not attack packing, this "Rotameter" has tapered glass metering tube set into two short fittings mounted in steel tube case threaded at each end and slotted at front for observation of tube and rotor. Stuffing box seat is steel ring force-fitted into steel case. 1 to 4-in. sizes, screw or flange connections.

Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa.

MULTI-STAGE CENTRIFUGAL PUMPS

HORIZONTAL-SHAFT, split-casing, double-suction, bronze-fitted, multi-stage centrifugal pumps for heads from 400 to 1,600 ft. and capacities to 400 g.p.m. Double-suction runners equalize end thrust. Each stage of casing has spiral volute. Between stages, liquid flows from one volute into long diffusion nozzle, then into long sweep return bend to inlet passages of following stage.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

CONDENSATE-RETURN UNIT

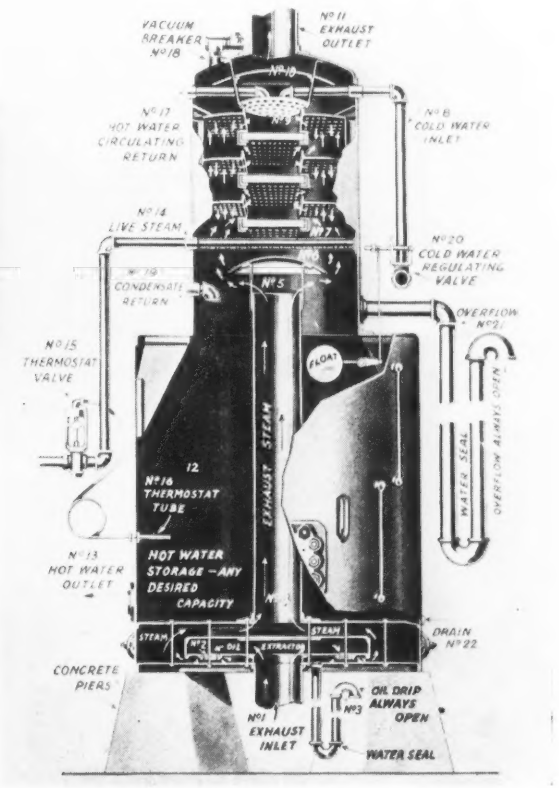
SIZES with 1,000 to 12,000 sq.ft. radiation, condensation unit for small steam plant has automatic control switch mounted on top, connected to copper ball float in tank. Governs operation and provides overload protection for motor. Tank and pump mounted on structural steel base. Strainer in suction line prevents scale and dirt from getting into pump.

Decatur Pump Co., Decatur, Ill.

HOT WATER HEATER

EXHAUST steam enters at inlet 1, passes upward into oil extractor chamber 2, where oil is removed by rapid expansion of steam and drained through pipe 3 in combined hot water heater, oil separator and storage tank. Steam vaporizes upward through pipe 4 to baffle head 5 and filling chamber 6, then contacts series of perforated plates and removable trays 7, while cold water is entering at inlet 8, and discharging downward into distributing pipe 9. Surplus steam passes upward to baffle 10, thence to exhaust outlet. Hot water discharged into storage chamber 12, leaves through hot water outlet 13. Additional steam enters inlet 14 controlled by thermostatic temperature control valve 15, and thermostatic tube 16. Arc-welded heaters have cast swinging doors.

Marshall Heater Co., 716-726 Monument Ave., Dayton, O.



POWER LINES

N.A.P.E. Steps Out At Pittsburgh

NATIONAL membership had grown nearly 1,000 net in the past year. The approach to license law progress had become clearer. Business pickup promised better days for all members. The power show was distinctly on the up and up. It was only natural, then, that a general spirit of energy and optimism pervaded the ranks of delegates as the National Association of Power Engineers assembled for its 53rd Annual Convention, this time at the William Penn Hotel, Pittsburgh, Pa., Aug. 26.

A notable feature of the 5-day gathering was the presentation of a well-considered plan to promote state license laws. The best N.A.P.E. power show in several years, and numerous well-attended social events, rounded out a convention that kept one of Pittsburgh's leading hotels humming for days.

Total registration of delegates (including the ladies auxiliary) and exhibitors ran to 2,800. Chicago was selected as the 1936 convention city.

Officers elected included:

President: F. A. Free, Chicago.

Vice-President: H. H. Wilds, New York.

Secretary: Fred W. Raven, Chicago.

Treasurer: Edw. J. Burke, Philadelphia.

Thomas F. Herlihy of Los Angeles, Calif., was elected trustee for 5 years. President Diebold appointed Cris Mattern, of Ohio, trustee, to fill out the unexpired term of H. H. Wilds, who resigned to accept the vice-presidency.

Opening officially on Monday, the convention got up full steam Tuesday morning in a great assembly presided over by Frank Kelton of Pittsburgh, general convention chairman. Speeches were made by Mayor McNair of Pittsburgh; G. M. Diebold, president; J. A. Prudell, national past-president; R. A. Free, national vice-president, and others.

In the sessions of succeeding days reports of officers and committees were presented and many other matters of business attended to. Meanwhile the Power Show was in full swing, and the Ladies Auxiliary held numerous business and social meetings.

Technical papers included a lecture on air pollution by H. B. Mellor, chief of smoke abatement, city of Pittsburgh, and one on coal by Prof. T. G. Estop of the Carnegie Institute of Technology.

Notable among the social events were the stag smoker Tuesday night, exhibitors' entertainment Wednesday night, and state dinners on Thursday.

Two subfloors of the William Penn Hotel were devoted entirely to exhibits of power and mechanical equipment, supplies and services. In all, 102 companies displayed products in one of the best shows of recent years. Visitors commented favorably on exhibits and the show in general. Exhibitors reported active interest in their displays.

In his report to the association, retiring national president G. M. Diebold stressed N.A.P.E. efforts to enact state license laws, particularly in New York, Pennsylvania, Wisconsin and California. He pointed to the need for more careful planning of such campaigns and the study of methods proved successful in promoting legislation. He praised the coordinating work of the license law committee (Bartley McCourt, Chairman, and T. G. Thurston, secretary). He announced a substantial improvement in membership during the year.

President Diebold concluded his report with detailed recommendations for a plan whereby the N.A.P.E. will give its members certificates of engineering merit in three classes, A, B and C, based mainly on years of responsible operating experience.

In an extended report, R. A. Free, national vice-president, reviewed many phases of N.A.P.E. work during the year. He pointed to a membership growth from 13,800 to 14,600. He recommended that power shows in connection with conventions of state associations be discontinued as an unwarranted drain on exhibitors. Mr. Free suggested that a power-plant cost division be included in its coming year's progress of the education committee.

Probably the two most vital functions of N.A.P.E. activities relate to education and the promotion of state license laws for power engineers. In the matter of laws, progress has been slow, if measured by actual enactments. However, Bartley McCourt, chairman, in presenting the report of the license law committee, revealed carefully thought-out plans based on the codification of experience to date. This work was carried out with the close cooperation of T. G. Thurston, editor of *National Engineer,* who acted as secretary. The full report of the committee, too long to abstract here, should be of great value to all engineers practically concerned with license law promotion.

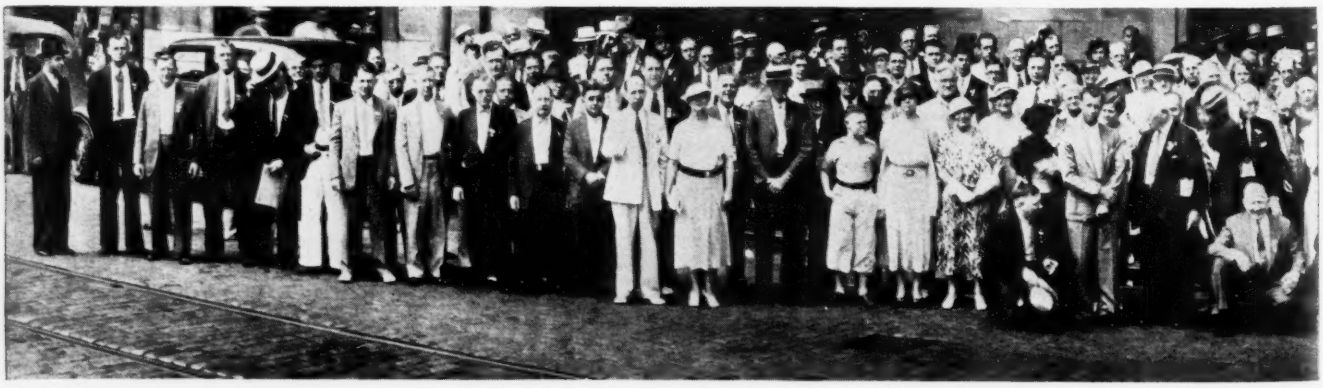
A.I.M.E. Papers

At a 2-day meeting of the Coal Division of the A.I.M.E. to be held in St. Louis, Mo., Oct. 28 and 29, the following papers will be presented: "The Future of Coal for Railway Fuel," by Eugene McAuliffe, president, Union Pacific Coal Co.; "The Future of Coal for Stationary Power," by E. H. Tenney, chief engineer of power plants, Union Electric Light & Power Co.; "Preparation, selection and Burning of Bituminous Coal for Steam Generation," by E. G. Bailey, vice-president, Babcock & Wilcox Co.; "Importance of Pulp Density, Particle Size and Feed Regulation in Flotation of Coal," by John T. Crawford, Preparation Department, Pittsburgh Coal Co.; "Value of Coals as Steaming Fuel as Indicated by Chemical and Physical Properties," by Henry Kreisinger, research engineer, Combustion Engineering Co., Inc.; "The Coal Basin West of the Mississippi River," by C. M. Young, professor of mining engineering, University of Kansas; "Economic and Competitive Position of Illinois Coal," by Walter H. Voskuil, mineral economist, Illinois Geological Survey and "Current Practice in Coal Preparation in Illinois," by H. F. Hebley, Allen & Garcia Co.

Increase in German Boiler Production

Production of German steam boilers was 60% higher in 1934 than during 1933. While total production slightly more than doubled, domestic sales tripled. While notable improvements have occurred in conditions affecting the steam boiler industry during the past two years, it has been estimated that present production capacity cannot be utilized at a rate of more than 60%. Ways and means must be found to liquidate excessive production capacity, and thus lower production costs.

They're not all in the picture. Total registration in Pittsburgh ran to 2,800.



Weirton Buys Two 400,000 Lb. Boilers

Weirton Steel Co., Weirton, W. Va., has ordered from Babcock & Wilcox Co., two Stirling, pulverized-coal and coke-oven gas-fired boilers designed for 900 lb. pressure, 815 deg., with a maximum capacity of 400,000 lb. of steam per hr., each. The boilers will have Bailey slag-tap furnaces, horizontal crosstube burners, superheaters and air heater. The boilers are expected to be in early next year.

Oil from Coal in England

Oil made by low-temperature carbonization from British coal has been shipped to the new plant of the Imperial Chemical Industries, Ltd., at Billingham, from the Barugh (Yorks) works of Low Temperature Carbonization, Ltd., recently. On arrival at Billingham the oil, which is made from coal by the Coalite process, is submitted to hydrogenation and converted into about 100,000 gallons of gasoline.

$19,000,000 Project

VERDE RIVER IRRIGATION AND POWER DISTRICT, Phoenix, Ariz., has private financing of $19,000,000 for hydro-electric power and irrigation project scheduled to begin in October. Contract for four dams, 130 miles of canal and subsidiary works awarded to H. T. Johnson Co., Merritt Bldg., Los Angeles, Calif., which will sublet parts. Main dam (Verde) between Boa Canyon and Cottonwood Creek will be of multiple-arch type, 263 ft. high and 800 ft. long, estimated to cost $1,650,000. Horseshoe Dam, near Maricopa-Yavapai county line, will cost $1,624,000. New River Dam will cost $1,172,000, and Bartlett Diversion Dam, $310,000. Two main hydro-electric generating plants will be built, at Camp Verde and Horseshoe stations. First is estimated to cost $634,000, second, $225,700. List of equipment being arranged. Transmission and distribution lines will cost about $960,000, power substations and switching stations, $250,000. The project will furnish power and water to 100,000 acres. Robert Young, Merritt Bldg., Los Angeles, consulting engineer.

Va. Electric to Add to 12th St. Station

VIRGINIA ELECTRIC & POWER CO., Richmond, Va., will build a $2,000,000 addition to the Twelfth-Street power plant with part of the proceeds of a $40,000,000 bond issue which the stockholders were asked to approve Sept. 27. Tentative plans suggest a high-pressure steam boiler to supply the entire plant and a new 12,500-kw. turbine with auxiliaries.

Index Endowment Not Yet Completed

Some months back Engineering Index, a service formerly operated at considerable loss by the A.S.M.E., was reorganized as an independent, non-profit institution. On the basis that the Index gives a reference service essential to scientific and industrial progress, an appeal was made to industry for a working capital fund of $160,000. This appeal came from a committee of engineers, educators and industrialists, headed by Dean Collins P. Bliss, Dr. Frank B. Jewett and Dr. John V. N. Dorr. A number of contributions, ranging up to $10,000, have already been received, but the fund is not yet complete.

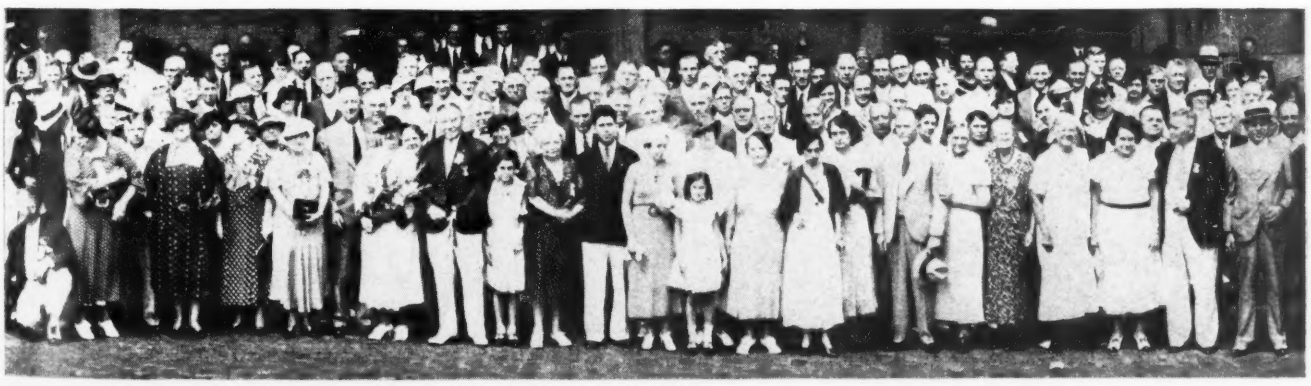
In addition to its annual volume, Engineering Index publishes a voluminous card index of technical literature, divided into 280 sections. About 2,000 publications from 40 countries and in 20 languages are reviewed by the Index editors.

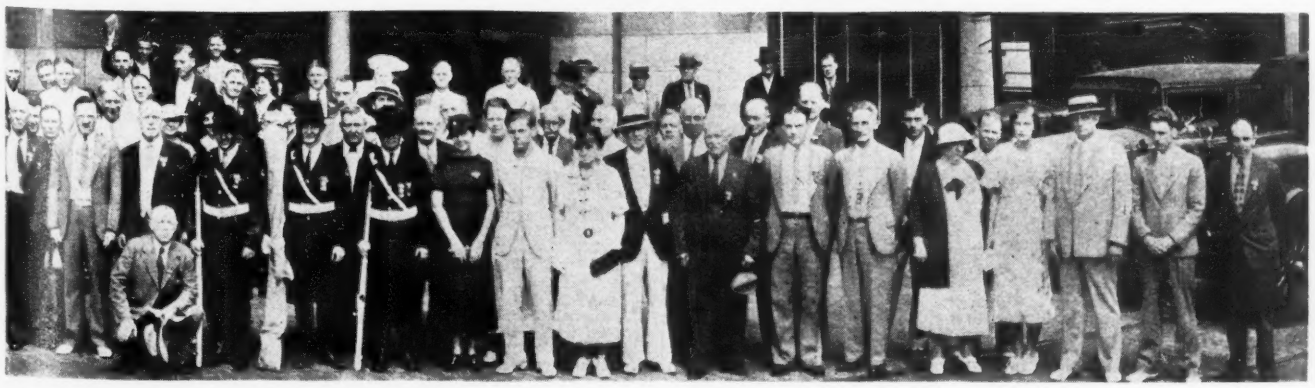
NEWS NOTES

WISCONSIN State legislature has passed a law requiring registration of all persons practising professional engineering. This applies to all branches of engineering. Architects and civil engineers have been registered in the past under a law of 1931. Information and application blanks from Arthur Peabody, secretary, Wisconsin Board of Examiners of Architects and Engineers, Capitol Building, Madison, Wis.

COURSES in diesel engineering have been inaugurated in widely separated schools throughout the United States. The University of California, Extension Division, Berkeley, Calif., reports a new correspondence course in diesel engineering. At the same time the Polytechnic Institute of Brooklyn, Department of Mechanical Engineering, 99 Livingston St., Brooklyn, N. Y., is giving a course in diesel and oil engines.

AMERICAN SOCIETY FOR TESTING MATERIALS, Committee E-10, on Standards, at a meeting Aug. 22, approved for publication as tentative 28 new standards, and approved revisions in 14 existing specifications. Among the new specifications were several submitted by Committee A-1 on steel, including: "Carbon Steel Castings for Miscellaneous Uses," "Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes," "Carbon-Steel Heat Exchanger and Condenser Tubes," "Forged Steel Pipe Flanges





for General Service," "Boiler and Firebox Steel for Stationary Service," "Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, etc., for Temperatures up to 1,100 deg. F." The new tentative standard covering heat-exchanger and condenser tubes resulted from work of a joint committee on which the American Petroleum Institute and Committee A-1 were represented. The new specification for alloy steel pipe flanges, forged fittings, etc., is a companion specification to the existing ones covering alloy steel pipe and castings. New specifications covering boiler and firebox steel for stationary service supersede the existing standard (A 70). They have been amplified to cover plates up to 4 in. thick, and provide for treatment for grain refinement and test requirements for heavy plates.

RULINGS on whether or not the United States, through the TVA., has the authority to sell electric power in competition with private utility plants, and the right of a municipality to build a power plant wih PWA funds, will be sought this fall from the U. S. Supreme Court. More than a score of other municipal power cases now in the lower courts will be affected by the latter decision.

EIGHTEEN engineering colleges and universities in New England and Middle Atlantic States have requested the Engineers' Council for Professional Development to consider their engineering curricula for accrediting. The plan will be put in effect this fall in the New England and Middle Atlantic States, and extended later to other regions of the United States. Both qualitative and quantitative criteria will be used. Qualitative criteria will be evaluated through visits of inspection by regional committees, quantitative criteria through data obtained from catalogs and by questionnaires. A list of approved institutions will be published.

15TH EXPOSITION OF CHEMICAL INDUSTRIES will be held in Grand Central Palace, New York, Dec. 2 to 7.

24TH ANNUAL SAFETY CONGRESS AND EXPOSITION of the National Safety Council will be held in Louisville, Ky., Oct. 14-18.

PERSONALS

WM. A. BRIGGS has been given charge of the southern sales district of Boston Woven Hose & Rubber Co., with headquarters at Atlanta, Ga.

COL. EARL BROWN, Corps of Engineers; Roger B. McWhorter, chief engineer of the Federal Power Commission; and Sherman W. Woodward, National Resources Board; have been appointed by President Roosevelt to investigate the feasibility of constructing a $17,500,000 dam on the Savannah River.

A. W. BURKET has been appointed district manager of the Griscom-Russell Co., with offices at 20 No. Wacker Drive, Chicago, Ill.

WILLIAM G. CHRISTY, smoke abatement engineer in charge of the anti-smoke campaign in Hudson County, N. J., has been asked to give New York City's health officials advice and counsel on a comprehensive survey of smoke and air pollution.

NELSON J. DARLING, manager of the River Works, General Electric Co., has also assumed the management of the West Lynn, Mass., works, upon retirement of F. P. Cox.

A. E. HEROUX has been appointed general manager of the Permite Paint Sales Division of Aluminum Industries, Inc., Cincinnati.

HAROLD L. GEIGER has been added to the field staff of the Development and Research Department of International Nickel Co. He was formerly connected with Wisconsin Steel Co. and Inland Steel Co.

CHARLES WELLINGTON KOINER, former city manager of Pasadena, Calif., has been appointed by Secretary Ickes as consulting engineer for PWA's new power division. In 1907, Mr. Koiner was general superintendent of the Los Angeles Gas & Electric Co., and in the following year was engaged by Pasadena to build and manage its municipal plant.

R. P. KILSBY has been appointed manager of the Western territory of Babcock & Wilcox Tube Co., with offices in Marquette Bldg., Chicago, Ill.

O. R. LANE has been appointed South Middle Western representative with headquarters at 455 Paul Brown Bldg., St. Louis, Mo., of Kennedy Valve Mfg. Co.

FRANK LIEBICH has been appointed district manager in charge of the Harnischfeger Corporation's operations in Detroit.

C. A. MCCUNE was awarded the Samuel Wylie Miller medal at the fall meeting of the American Welding Society, at Chicago, Sept. 30.

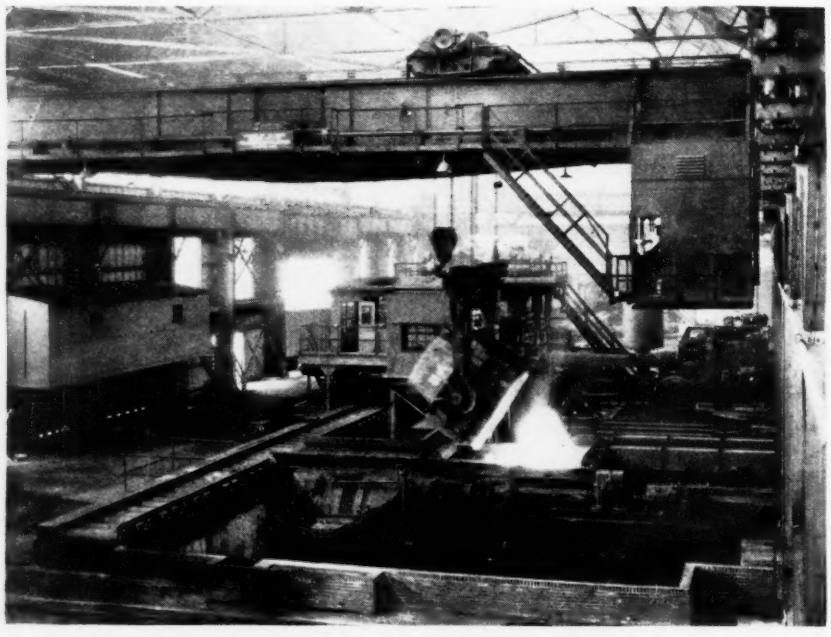
T. I. PHILLIPS has been appointed general works manager of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

B. J. SCHNEIDER, 909 Roosevelt Bldg., Indianapolis, Ind., has been appointed district representative for the C. O. Bartlett & Snow Co., Cleveland, Ohio.

WALTER L. TANN has joined the Engineering Department of Farrel-Birmingham Co., Inc., Ansonia, Conn. He has been engaged in design of the mechanical and hydraulic equipment in the Rockefeller Center, New York, N. Y.

DON S. WALKER has been appointed district manager in the Philadelphia office of Combustion Engineering Co., Inc.

CLEMENT CLARENCE WILLIAMS, dean of the College of Engineering, University of Iowa, has been elected president of Lehigh University to succeed Dr. Charles Russ Richards, recently resigned.



Air-Conditioned Cab

It used to be hot, in fact 120 deg. in the cab of this hot-metal crane in A. M. Byers Co. plant, but air conditioning has now made it comfortable for the operator. A Curtis-type unit driven by ½ hp. motor now maintains a temperature of 70 to 75 deg. Cold-air outlet is in corner farthest from the operator and return inlet at corner nearest operator. Cab is insulated with 1½-in. asbestos sheathing. Cooling unit, 15x16x14 in., is on top of the cab

OBITUARIES

DAVID J. CHAMPION, 74, president and founder of the Champion Rivet Co., Cleveland, Ohio, died Sept. 10. Mr. Champion started to work for the Lake Shore Railroad but soon changed to a court stenographer in Cleveland, then to stenographer at the Cleveland Rolling Mills Co., where he got the idea for the manufacture of steel rivets.

OSCAR JUNGGREN, 70, pioneer designer of large, high-speed, steam turbines for General Electric Co., Schenectady, N. Y., died Sept. 24. Mr. Junggren cooperated with W. L. R. Emmet in the designing and construction of the first large Curtis turbine in 1903. Between 1924 and 1932 he developed 30 original turbine designs, including the steeple compound for which he was awarded the Charles A. Coffin medal in 1931.

WILLIAM S. BURLEIGH, 45, Boston, Mass., mechanical engineer, specializing in industrial efficiency problems, died Sept. 3.

SAMUEL DONAGHY, 81, plant engineer at Rhode Island Hospital, Providence, died Sept. 1.

B. H. JOHNSON, vice-president, American Foundrymen's Association, and assistant to

the president, R. D. Wood Co., Philadelphia, Pa., died Aug. 27. He had been a director of the A.F.A. and a representative of the Gray Iron Institute on the Joint Committee on Foundry Education in Engineering Schools.

AUSTIN LEAVITT, 78, prominent in the steam fitting and supply business at Melrose, Mass., died Sept. 4.

PATRICK HACKETT, 86, retired operating steam engineer with Iver Johnson Co., Fitchburg, Mass., died Sept. 7.

JAMES L. MOXSOM, 56, retired engineer at Searles High School, Methuen, Mass., died Sept. 4.

HARRY E. STITT, 58, chief engineer, Austin Co., Cleveland, Ohio, died Aug. 23. Mr. Stitt is accredited with having originated the principle of standardized unit construction for modern industrial buildings. He also pioneered in the application of welding to industrial construction.

FOREIGN SHORES

KANDALAKSHA (KARELIA) U.S.S.R., has work in progress preliminary to constructing a new 120,000-kw. hydro-electric power station in the Transarctic region. The station "Niva-3" is being erected near a waterfall on the Niva river.

CONSOLIDATED GOLD ALLUVIALS COMPANY had a power-plant explosion at Wingdam, 30 miles east of Quesnel, B. C., which caused damage estimated at $100,000, including the loss of three big diesel-generator units. A temporary steam plant is being installed to take care of the camp's needs while a new power house is being built.

BRITISH COLUMBIA provincial government has a survey party under the direction of R. C. Farrow investigating the possibilities of developing 1,750,000 hp. on the Fraser River, B. C.

NORTH METROPOLITAN ELECTRICAL SUPPLY CO. has ordered two 210,000-lb. per hr., 930-deg., 1,900-lb. pressure, Loeffler boilers for Brimsdown "A" Power station, North London, England, from Mitchell Engineering, Ltd., England.

MEXICO CITY, MEXICO, has broken ground and laid fibre ducts in several streets while the sale of a limited amount of power from a provisional 4,000-hp. plant is expected within six months. The Amacuzac Hydro-Electric Co. expects to be able to supply 150,000 hp. in about two years. The plant, which will have an ultimate capacity of 500,000 hp., is located 63 miles from Mexico City in the State of Morelos at Xicatlacotla, where the Amacuzac River will be diverted.

BUSINESS NOTES

ELECTRIC PLANT OWNERS ASSOCIATION, INC., 11 Park Place, New York, N. Y., has been chartered as a membership corporation whose purpose is "to unite the owners and operators of private electric generating plants in the city and state of New York, for the protection and promotion of their common interests. . . ." The officers are, Chauncey Depew Steele, president, Sylvan L. Hanauer, treasurer, and Rives Matthews, secretary.

INTERNATIONAL HARVESTER CO., 606 South Michigan Ave., Chicago, Ill., is completing plans and will soon take bids for new power plant at truck manufacturing works, Springfield, Ohio. Cost about $150,000, with equipment. W. L. Dunn, company engineer, Springfield.

AJAX FLEXIBLE COUPLING CO. has moved its Philadelphia sales office to 1108 Otis Bldg. V. L. Sanderson is representative in charge.

CARBONDALE MACHINE CORP., Harrison, N. J., subsidiary of Worthington Pump & Machinery Corp., has announced the election of the following officers: H. C. Ramsey, president; H. A. Feldbush, vice-president; A. H. Baer, vice-president in charge of sales; and A. L. Prentice, secretary-treasurer.

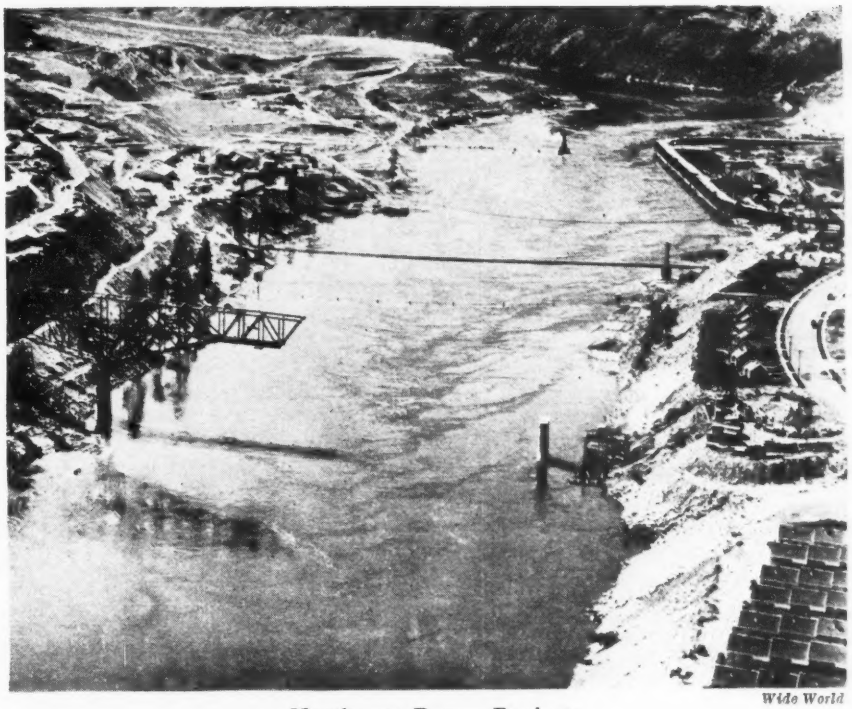
CHAPMAN VALVE MFG. CO., Indian Orchard, Mass., and Pelton Water Wheel Co., San Francisco, Calif., have agreed to exchange patents, manufacturing facilities and sales efforts on their hydraulic valves.

MILLER STEEL CO., Newark, N. J., has been appointed distributor for Globe Steel Tubes Co., Milwaukee, Wis.

REPUBLIC STEEL CORP., Youngstown, Ohio, has opened a new sales office at 622 Dwight Bldg., Kansas City, Mo., under the direction of Robert L. Pierce.

CHARLES A. STRELINGER CO., Detroit, Mich., has been appointed agents for the General Refractories Co., Philadelphia, Pa.

U. S. DIESEL ENGINEERING SCHOOL has moved to 89 Brighton Ave., Boston, Mass.



Wide World

Northwest Power Project

Grand Coulee damsite at Columbia River with highway bridge, now under construction at left, leading from Mason City, the contractor's camp, to Bureau of Reclamation construction camp at right.

NEW BULLETINS

Thermometers—C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y. 24-page profusely illustrated catalog No. 1125. Complete description of line of industrial thermometers.

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. Four 4-page leaflets give dimensions and characteristics of centrifugal, horizontal-duplex piston and sump pumps and air-lift pumping systems operated by air compressors.

Boilers—Springfield Boiler Co., Springfield, Ill. 40-page Catalog No. 35 illustrates and describes numerous recent installations of all-steel sectional boilers.

Valves—Fairbanks Co., Boston, Mass. 56-page, 2-color catalog contains 96 illustrations of valves with descriptions and prices. Also data on unions.

Mechanical Transmission—Medart Co., St. Louis, Mo. 144-page catalog No. 56-T gives complete information on line of mechanical transmission equipment, including friction clutches, belt tighteners and adjusters, hoisting sheaves and rope drives.

Combustion Control—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio. 32-page illustrated bulletin No. 102 shows how an air-operated combustion control system may be applied to boilers ranging in sizes from 2,000 sq.ft. up.

Synchronizer — Allis-Chalmers Mfg. Co., Milwaukee, Wis. 4-page illustrated leaflet No. 2202, describing a synchronizing device for automatically paralleling a.c. generators.

Disconnect Switches—Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill. Bulletin No. 35-B gives complete data on ratings, dimensions and characteristics of hook-operated and group-operated disconnect switches, for rural line service up to and including 34.5 kv.

Starters—Allen-Bradley Co., Milwaukee, Wis. Clever cut-out bulletin No. 709 in three colors gives complete details and characteristics of line of automatic starters.

Metal Spraying — Metallizing Co. of America, 1218 Long Beach Ave., Los Angeles, Calif. 4-page pamphlet covers use of metal-spraying equipment on general maintenance applications, and illustrates recent jobs and possible applications.

Steam Distribution — American District Steam Co., North Tonawanda, N. Y. New addition to general catalog gives detailed information on company's entire line.

STRAWS

Pointing the way business winds blow

South and Southwest

NORRIS DAM will be completed about Jan. 1, 1936, in slightly less than two years from time work began, according to latest indications. The $34,000,000 dam is 253 ft. high, contains more than 825,000 cu.yd. of concrete. The powerhouse will contain two 66,000-hp. generators, to be installed prior to May 1, 1936.

KNOXVILLE, TENN. Construction of three new TVA dams, Hiwassee, Chickamauga and Guntersville, will be started as soon as suitable sites are located.

GEORGIA state administration has applied to PWA for $350,000 to build a heating, lighting and power plant to serve the State Prison Farm, State Women's College and the Hospital for the Insane at Milledgeville, Ga.

BESSEMER AND PARRANT CITY, ALA., PWA loans and grants of $1,238,182 and $329,091 for the construction of distribution systems and interconnection with TVA have been tentatively approved.

WASHINGTON, D. C., union depot has installed a fleet of 21 portable generator sets consisting of a.c. squirrel-cage motors direct-connected to low-voltage d.c. generators and necessary control apparatus, to charge batteries and serve as auxiliary power supply to operate refrigerating units while cars are at a standstill.

TVA, Knoxville, Tenn., has awarded $130,281 contract to General Electric Co., Schenectady, N. Y., for electrical equipment at Norris Dam. Similar contract for electrical equipment at Joe Wheeler dam has been let to Westinghouse at $127,265.

BOARD OF LAUDERDALE COUNTY COMMISSIONERS, Florence, Ala., plans one or two community cold-storage and refrigerating plants, to be located at St. Florin and Rogersville. Financing through PWA.

INMAN, S. C., plans municipal cold storage and refrigerating plant for fruit packing. $107,000 for buildings and equipment is being secured through federal aid. L. E. Graddick, Harris Bldg., Spartanburg, S. C., engr.

U. S. ENGINEER OFFICE, Huntington, W. Va., has awarded $98,881 contract to the Beltzhoover Electric Co., Fourth & Plum Sts., Cincinnati, Ohio, for construction of power plant at Gallipolis Dam on Ohio River, near Hogsett, W. Va., including equipment.

DALLAS, TEX., plans large boiler plant in proposed county court house, for which $2,500,000 fund is being arranged. Lang & Witchell, Dallas, architects.

PARAGOULD, ARK., has secured federal loan and grant of $200,000 for municipal power plant and distribution system, and will proceed with project early this fall.

TAFT, TEX., is considering steel pipe line distributing system for natural gas service to cost about $40,000. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, Tex., consulting engineer.

SAN ANTONIO, TEX., plans new municipal electric and gas plant, to cost about $16,000,000, of which about $7,000,000 will be financed through federal aid. Electric station will cost approximately $11,000,000.

BILOXI, MISS., has submitted tentative plans for establishment of a $600,000 municipal power plant to the PWA.

SAVANNAH (GA.) ELECTRIC CO. purchased a 7,500-kw., 13.8-kv., turbo-generator through Stone & Webster from General Co., which will operate at 3,600 r.p.m., is designed for 400 lb. steam pressure and has a 7,800-sq.ft. Westinghouse condenser.

NORTH CAROLINA FINISHING CO., Yadkin, N. C., has installed a new Combustion 2-drum boiler designed to deliver 60,000 lb. of steam an hour at 425 lb. pressure and 550 deg. with an efficiency of 85.5%. Unit is fired with pulverized coal from two Raymond impact mills and has 8,060 sq.ft. of heating surface. Front tubes are 3 in. in diameter and rear tubes 2 in.; both top and bottom drums are welded. Installation was completed in 90 days.

PONCA CITY, OKLA., plans installation of 2,000-kw. engine-generator unit and auxiliary equipment in municipal electric plant. $175,000 bond issue being arranged for work.

ALLIANCE, NEB., plans extensions and improvements in municipal electric power plant, and will ask bids at early date. Cost about $225,000. Financing through federal aid. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

FAIRBURY, NEB., is considering extensions and improvements in municipal electric power plant, including installation of new boilers and auxiliary equipment. Water & Light Commission, J. L. Thornton, chairman.

PUEBLO, COLO., has plans nearing completion for municipal electric plant, and will order equipment in near future. Reported to cost over $200,000. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

CHANUTE, KAN., plans extensions and improvements in steam-electric municipal station, including new equipment. E. A. Pearce, superintendent.

WELLINGTON, KAN., has engaged Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers, to prepare plans for $100,000 municipal electric plant and distribution system. Bids will be asked at early date. Financing through Federal aid.

EUREKA, KAN., plans municipal electric plant and distribution system, estimated to cost $70,000. Financing through federal aid, Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

INTERNATIONAL DISTILLERY CORP., Arvada, Colo., plans installation of $60,000 boiler house in new local distillery. Lester L. Jones, 1425 Welton Street, Denver, Colo., architect.

JAMESTOWN, N. D., has awarded general contract to Donovan Construction Co., 1725 Carroll Ave., St. Paul, Minn., for municipal electric plant, for which PWA approved $745,000 loan and grant. Contractor will arrange sub-contracts. Electrical distribution system and pipelines for central steam heating will be built. Work begins soon. Gilbert R. Horton, city engineer, in charge.

IOLA, KAN., plans extensions and improvements in municipal steam-electric plant, including addition to power house and new equipment. Cost about $280,000. Financing through federal aid. Paulette & Wilson, Farmers Union Bldg., Salina, Kan., consulting engineers.

ARKANSAS CITY, KAN., plans installation of large electric-operated pumping station for water supply system at Silver Creek, about 11 miles from city, including pipeline installation. Fund of $700,000 is being arranged through federal aid. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

Lake States

FERRO STAMPING MFG. CO., 1367, Franklin St., Detroit, Mich., has approved plans for one-story power plant in proposed factory on Woodbridge Ave., for which superstructure will soon be placed under way. Entire project will cost close to $70,000. Giffels & Vallet, Inc., Marquette Bldg., city, architect and engineer.

ADRIAN, MICH., plans municipal electric power plant and electrical distributing system. $650,000 arranged through federal aid.

STATE BOARD OF CONTROL, State Office Bldg., St. Paul, Minn., is arranging financing of $114,000 for power house at institution for feeble-minded at Faribault, Minn., for central heating and other power services. Pillsbury Engrg. Co., 1200 Second Ave., South, Minneapolis, Minn., consulting engineer; A. F. and R. R. Gauger, New York Bldg., St. Paul, architects.

LAKE DELTON, WIS., is arranging federal financing of $152,460 for new municipal electric plant, for which bids will soon be asked. John Chaffee, chairman of town board, in charge.

VALIER COAL CO., Benton, Ill., plans rebuilding of boiler house at coal-mining properties recently damaged by fire. New equipment includes boilers and stokers.

CHICAGO, ILL., SMOKE BUREAU has asked W.P.A. authorities for $400,615 to employ 512 individuals to conduct a 9-month survey of smoke conditions in that city. The New York Board of Health has made a request for federal funds of $131,000 for the same purpose.

LANSING, MICH., plans construction of welded steel pipe line from Michigan natural gas fields to city for commercial gas supply. Entire project will cost about $600,000. Application to PWA for federal loan and grant.

HOWARD, S. D., has contracted with Fairbanks, Morse & Co., Chicago, Ill., for installation of Diesel engine-generator unit in municipal power plant, replacing present steam-operated equipment, at cost of $43,456.

DANVILLE, KY., is considering municipal electric plant, and distribution system, estimated to cost $350,000. City engineering department in charge.

GREENFIELD, OHIO, has secured a $76,300 federal loan and grant for extensions and improvements in municipal electric and waterworks plants. Will include 750-kw. turbine-generator, two exciter sets, condensers, superheaters and accessory equipment. Work scheduled to begin soon. W. I. Barrows, Reibold Bldg., Dayton, Ohio, consulting engineer.

BELLEVUE, OHIO, plans new pumping plants, including high speed and high capacity station, in connection with extensions and improvements in municipal water system. Low-lift station will also be installed. Fund of $191,300 secured through federal aid. Bids will be asked for pumping machinery and other equipment at early date. George P. Gascoigne & Co., Leader Bldg., Cleveland, Ohio, consulting engineers.

EAU CLAIRE, WIS., plans $30,000 steam power plant at County Asylum for central heating service. Financing through federal aid.

HUTCHINSON, MINN., has applied for federal loan and grant of $250,000 for municipal electric plant, purchase of existing distribution system of Northern States Power Co., and extensions and improvements. Buell & Winter Engrg. Co., Insurance Exchange Bldg., Sioux City, Iowa, consulting engineer.

RACINE, WIS., plans steam power plant at county sanatorium for central heating service. Financing of $34,500 arranged through federal aid.

GARDNER-RICHARDSON CO., Middletown, Ohio, plans power-house addition at Lockland, Ohio, paper mill to cost over $125,000. Contract to Combustion Engineering Co., New York, N. Y., for boiler and accessories; and to American Engineering Co., Philadelphia, Pa., for stokers. Awards for other equipment will be made soon.

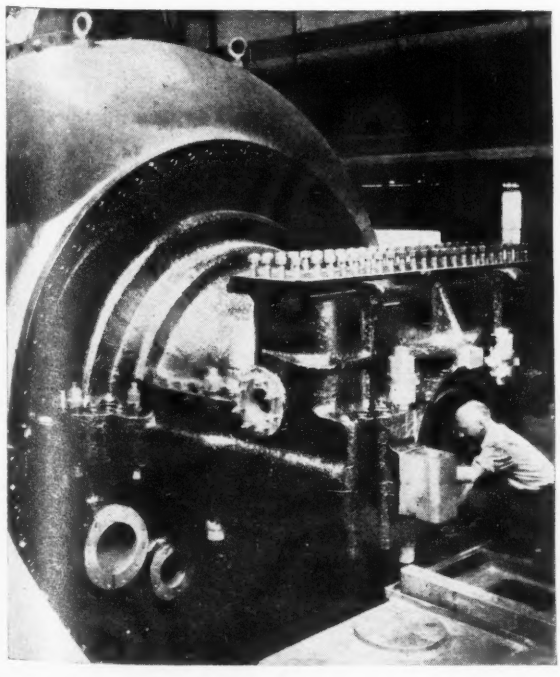
BITTER ROOT FRUIT & VEGETABLE GROWERS' Ass'n, Hamilton, Mont., is planning early construction of $200,000, multi-story cold storage and precooling plant.

SACRAMENTO MUNICIPAL UTILITY DISTRICT, Sacramento, Calif., has made application for federal aid of $5,000,000 for proposed power project, estimated to cost from $10,000,000 to $12,000,000. Plans are under way for $3,000,000 generating station, transmission and distributing lines, power substations and service facilities, to cost approximately $7,000,000. Project will require about 2 years for completion. Albert E. Given, chief engineer of District.

INDEPENDENT NATURAL GAS PRODUCERS OF MONTANA, Great Falls, Mont., E. B. Coolidge, Great Falls, president and representative, has concluded arrangements with municipalities in North Dakota, Minnesota and Wisconsin to carry out joint financing of $60,000,000 through federal aid for construction of welded steel pipeline from Montana natural gas fields to supply communities along route Branch lines and pipeline distribution systems will be built. Surveys being made. John W. Schmidt, Anoka, Minn., head of municipal delegation.

PACIFIC GAS & ELECTRIC CO., San Francisco, Calif., has awarded contract for first section of 22-in. electric-welded steel pipe line, for natural gas service, to Youdall Construction Co., Matson Bldg., San Francisco. 31½-mile line extends from San Francisco-San Mateo county line to point near Palo Alto. Second section of 13½ miles, extending to connection with Kettleman Hills natural-gas fields, will be built under another contract or by company forces. Company has arranged for another source of natural gas supply from properties of Amerada Petroleum Corp., Tracy, Calif., and plans early construction of welded steel pipeline from that point to connection with existing trunk-line system. Cost over $200,000.

BUREAU OF RECLAMATION, Interior Department, has been allotted $5,000,000 for the completion of the Roza division of the Yakima Reclamation project, which will provide for construction of a diversion dam, 99 miles of main canal, tunnels, siphons, 500 miles of laterals, and a 12,000-kw. hydro-electric unit.



LOS ANGELES, CALIF., is arranging $14,400,000 federal aid for extensions in waterworks system. $5,125,600 for water development and supply project at Mono Basin, and $1,500,000 for Long Valley dam and supply lines. Project will include new electric-operated pumping stations. Total cost $6,989,000. Improvements in Owens Valley aqueduct to cost about $785,000. Lloyd Aldrich, city engineer.

For Connors Creek

Last of three Detroit Edison Company's 20,000-kw. steam turbines whose capacities have been increased to 50,000 kw. each, by rebuilding and modernizing to operate at 600 lb. pressure. Unit is shown on floor of General Electric turbine shop at Schenectady just before shipping to Connors Creek Station

GRAND RIVER DAM AUTHORITY, Oklahoma City, Okla., J. M. Maurer, consulting engineer, plans hydro-electric power and flood control project in Mayes County. Power dam will be constructed on the Grand River, near Pensacola, Okla., with generating station, transmission lines, substation and switching stations. Flood control development will form primary feature, including group of electric-operated pumping stations. Total appropriation $15,998,000 in progress through federal aid. J. Howard Langley, Pryor, Okla., chairman of Authority.

BANNING, CALIF., has authorized construction of municipal electric plant, using diesel-generating unit. J. Blair Neely, city engineer, has been instructed to prepare plans and arrange site.

CENTRAL VALLEY, CALIF., has been allotted $20,000,000 for conservation of the San Joaquin and Sacramento River basins in central California, at an estimated cost of $170,000,000. It will be necessary, prior to the completion of the project, to construct a standby steam plant for generation of electric power and a distribution system in the vicinity of San Francisco Bay, to make full use of the hydro-electric power to be generated at a high dam on the Sacramento River, Calif.

SEWARD, ALASKA, is issuing bonds for $89,000 and will secure a grant of $30,000, for municipal electric plant, for which plans will soon be completed by Hubbell & Waller Engrg. Corp., Alaska Bldg., Seattle, Wash., consulting engineer. New station will be hydro-electric type, securing water supply from Lost Lake, about 10 miles from city, with power station about 7 miles distant and 3-mile pressure pipeline constructed from that point to water source. Initial installation will comprise two 420-hp. generating units.

East

TIMES-UNION BUILDING, Rochester, N. Y., is installing a year-round air-conditioning system. 45,000 cu.ft. of conditioned air will be circulated per minute, including 20,000 cu.ft. of ventilation air from outdoors. The system's cooling capacity will be 1,320,000 B.t.u. per hour, using five 20-hp. compressors and one 5-hp. compressor.

CITY HOSPITAL DEPARTMENT, Boston, Mass., plans extensions and betterments in power house, including new equipment. Bids soon. James H. Ritchie & Associates, 100 Arlington St., Boston, architects.

WEST GLOUCESTER, R. I., has installed a 50-kw. diesel-driven generating plant as a result of opening the interstate transmission lines connected with the Connecticut Light & Power, Hartford Electric Light and Connecticut Power companies. This opening was caused by the signing of the holding company regulatory act by President Roosevelt.

CITY HOSPITAL, Worcester, Mass., is planning construction of power house. Estimates of cost will be made soon. City engineer, in charge.

CONSTRUCTION QUARTERMASTER, U. S. Military Academy, West Point, N. Y., plans extensions and improvements in power house to cost about $150,000.

COMIN' UP . . .

I've seen good men operate. They do the best job they possibly can—they don't worry about competition from men working for them and they're not afraid to teach anybody as much as he'll take the trouble to learn.

I want to run that kind of an outfit. I don't want to be tied hand and foot to the plant because nobody that works for me knows what to do. I want to be able to go across the street for a cup of coffee or take a couple of days off to go fishing without expecting trouble. It's a lot easier for me and the men who work for me to teach them everything they're willing to learn. We get the satisfaction and mutual trust of doing a good job together.

After all, when I'm teaching a man I'm learning myself, and I'm reviewing a lot of things that otherwise might slip my mind. As fast as I pass out what I know, there's more new experience coming along, experience that I can tie in with the old to get an answer that the younger man hasn't enough background to get.

I'm not afraid that one of my men will know as much as I do—I'm afraid that one won't! There are two sides to my job—one is steam and power production, the other coordination and training. I'm expected to keep the plant operating economically, and I can't do that unless every man is pulling with me.

I've always tried hardest to make the younger men read and learn; if an older man doesn't want to do it, that's his privilege. The young man is pliable, and if he once forms the right habits of reading and learning, he'll get a long way.

Of course there are still those who believe that the only way a man can learn is by experience, that "nobody can't learn nothing from no books." They're wrong; the men who come up from behind to pass them have proved it.

When smart men who work for me ask what to read, I advise books, magazines, bulletins, catalogs—anything authoritative. All are helpful. Once I used to write and mimeograph my own set of instructional manuals, but I've learned now that it's better to recommend published things and to supplement them as necessary to meet our particular case.

Some engineers don't realize how helpful the advertising is in a magazine, and think it's just so much extra paper. Really, it's almost another magazine full of worthwhile data. I believe the maker of power equipment knows as much about his product as I do about my plant. If he's willing to give me straight facts, I'm willing to take 'em. For that reason I enjoy the series of letters from "A Chief Engineer to His Son," "Your Bonus from Our Torture Chamber," "Bringing Inside Information Out," "To Insure Continuous Test Results from Your Boiler Plant," and dozens of others in this number—they all tell me something, give me another piece of information to add to what I already know.

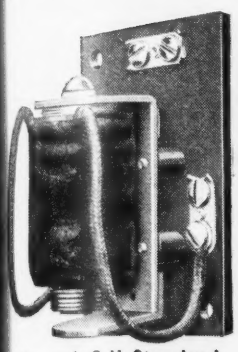
Another recent source of good operating data has been the special sections in *Power*, four of them so far this year, I think. They're great stuff for ABC training for me as well as for the boys. I've got them in my files, and some of the boys have them in binders so they can dig them out and brush up on them once in a while. And those boys are the ones I'm watching, because they're the boys that are comin' up!

George Edwards

GEORGE EDWARDS
Engineer

MODERN MACHINES ARE AUTOMATIC

Relays of All Types . . . Time Proven Save Time and Costs in Designing Electrical Machines for Today's Needs



Above: A C-H Standard Single Pole Relay designed for low-coil wattage. Used today on many machines for its sensitivity.

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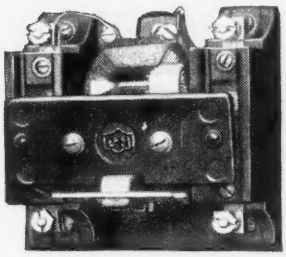
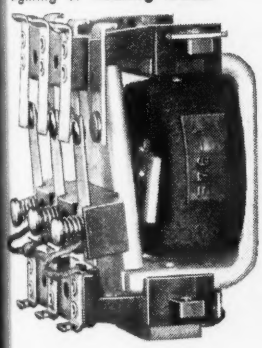
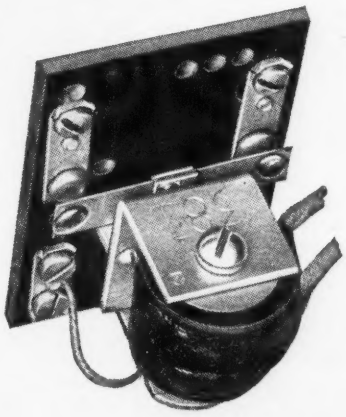
At right: A C-H Standard Two-Pole Heavy Duty Relay used for controlling motor, lighting or heating loads.



Below: A Standard C-H Relay developed originally for extreme sensitivity and secure against vibration. Used on an ever increasing number of machines with electronic tube control.



Above: A C-H Standard Three-Pole Double Throw Relay used on a large number of devices as a transfer switch. Such a relay, at the touch of a button or at the closing of an inbuilt contact provides, for instance, automatic reversal.



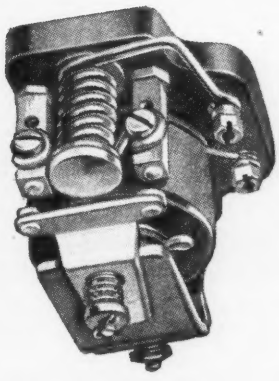
● This has been called the "push-button" age . . . quite rightly so, as anyone can see quickly in any modern factory. Modern machines are largely automatic. They start at the push of a button, they go through one operation after another automatically—or at the touch of another button or two—and they stop automatically or when the operator touches another button.

If you would build *modern* machines—the kind people are ready to buy today—they will be as nearly automatic as you can make them. And this will mean they incorporate from one to a score of *relays* . . . the brain cells of electric control.

Cutler-Hammer, through decades of Motor Control leadership, has literally hundreds of relays for almost every needed service fully developed and proven in actual service. When you need relays, put your problem before Cutler-Hammer. Instead of time-wasting, costly weeks of development, a few minor changes in a standard C-H Relay may be just what you seek. Ask Cutler-Hammer *first.* CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1358 St. Paul Avenue, Milwaukee, Wis.

A VALUABLE HOW-TO-DO BOOK

Every machine designer or executive interested in the possibilities of automatic control should read this interesting and valuable booklet—a how-to-do-it book that may save any manufacturer thousands of dollars in needless development. Write for your copy today.



At left: A Standard General Purpose C-H Relay developed for D. C. and A. C. service. Used today on scores of small D. C. Motor applications.

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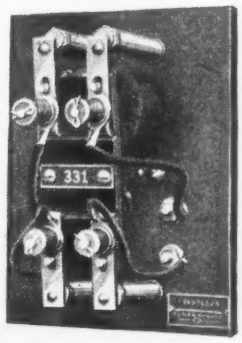
At right: A Standard C-H Relay widely used in pilot control circuits, as a transfer switch, etc.



CUTLER-HAMMER MOTOR CONTROL

STARTS ★ STOPS C-H REGULATES ★ PROTECTS

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Palo Alto—City plans application to P.W.A. for funds to finance construction municipal electric power plant. $727,000. J. F. Byxbee, city engr.

Calif., Sacramento—Golden State Soda Wks., 1715 15th St., plans by J. A. Saunders, 1045 45th St., alterations and extensions to 1 story heating and power plant.

Colo., Delta — City plans municipal hydro-electric plant. P.W.A. approved $197,000 loan and grant. Owner will call bond election to approve federal loan and grant. Wood & Weber, 1035 Pearl St., engrs.

Fla., Avon Park—Municipality plans electric light and power plant, distribution lines. $75,-000. G. A. Main, Daytona Beach, engr.

Ga., Savannah—Savannah Electric & Power Co., 27 West Bway., Savannah, plans extensions to power plant. $360,000.

Ill., Edwardsville — City, W. C. Straube, mayor, plans constructing municipal light and power plant, equipped with either Diesel engines or steam generating units, etc. $384,600-$393,-000. C. E. Smith & Co., Railway Exch. Bldg., St. Louis, Mo., engrs.

Ill., Maywood — Village, C. O. Krausser sketches complete light plant. $152,000. Applied for P.W.A. funds. Consoer, Townsend & Quinlan, 205 West Wacker Dr., Chicago, engrs.

Ill., Valier — Valier Coal Co. plans power house and equipment. Maturity indefinite. Architect not appointed.

Ind., Evansville—Southern Gas & Electric Co., Evansville, filed petition with Indiana Pub. Service Comn., State House, Indianapolis, for permission to finance the following improvements and installations: 12,500 kw. turbine generator set at Ohio River plant; two substations, Stringtown and Morgan Rds., $80,000 each; switch connection, Ohio River plant, $12,-500, switch connection Division St. plant, $13,-700.

Ind., Ft. Wayne—Bd. P. Wks., H. W. Baals, mayor, City Hall, plans municipal electric light plant improvements, incl. new boiler room, auxiliary bus structure, switching connections, cell structures, control meters, etc. $300,000. P.W.A. project. P. F. Thiele, c/o owner, engr.

Ia., Rock Rapids—City, L. A. Riter, mayor, plans light and power plant, equipment to include steam turbines and to convert system from direct to alternating current. $225,000 or more. Applied for $95,000. P.W.A. grant. Black & Veatch, 4706 Bway., Kansas City, Mo., engr.

Kan., Iola—City plans new power plant also generating units, turbine improvements, at rein.-con. dam. $280,000. Application filed with P.W.A. for loan and grant. Paulette & Wilson, Salina, engrs.

Kan., Phillipsburg—Municipality plans Diesel powered electric light and power plant. $120,-000. Paulette & Wilson, Salina, engrs.

Kan., Wellington — City plans power plant and distribution system. $100,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Ky., Russell—City plans election in November to vote bonds for construction electric light plant. $60,000. Will seek P.W.A. loan and grant.

Me., Summersville — City, M. S. Dewoody, mayor, plans municipal light and power plant, equipment and distribution system. $24,020. Applied for $10,809 grant and $13,210 loan from P.W.A. Beard Eng. Co., 44 South Central Ave., engrs.

Mass., Boston—City, Hospital Dpt., 818 Harrison Ave., sketches by Jas. H. Ritchie & Associates, 100 Arlington St., power plant addition and alterations, 818 Harrison Ave. To exceed $40,000.

Mass., Worcester—City, Mayor's Office, City Hall, plans by Major E. Tucker, house engr., City Hospital, power plant at city hospital. P.W.A. $25,000 funds asked. Total est. exceeds $40,000.

Mich., Flint — City reports completed light plant and distributing system. $2,000,000. Will apply for P.W.A. loan and grant. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Miss., Waynesboro—City applied to P.W.A. for $55,000 loan and grant to construct municipal light plant. E. L. Malvaney, Jackson, archt.

Minn., Marshall—City plans furnishing, installing improvements at municipal power plant. $74,000. P.W.A. funds applied for. G. M. Orr & Co., 408 Baker Bldg., Minneapolis, engrs.

Minn., Mountain Iron — Municipality plans constructing extensions and additions to Diesel engined electric power plant. C. Foster, Duluth, Minn., engr.

Minn., Murdoch — Village, A. E. Peterson, clk., making plans waterworks system, incl. pump house, deep well centrifugal pump, 50,-000 gal. tank and tower, 12,000 lin.ft. cast iron mains, 20 hydrants, etc. $30,000. (Well is already drilled.) E. G. Briggs, 1955 University Ave., St. Paul, engr.

Mo., Cabool—City, T. Conklin, mayor, plans municipal light and power plant, $50,000. Applied for P.W.A. grant $22,000 and $28,000 loan. Contemplate bond issue to cover loan if approved. M. B. Messler, 918 South Bway., Springfield, engr.

Mo., Licking—City, L. Randall, acting mayor, plans light and power plant and distribution system. $31,844. Applied for $14,329 grant and $17,514 loan from P.W.A. Beard Eng. Co., 44 South Central Ave., Clayton, engrs.

Mo., Macon — City plans electric generating equipment for municipal plant. $80,000. Applied for $36,000 grant from P.W.A. Baumes-McDevitt Co., 1871 Railway Exch. Bldg., St. Louis, engrs.

Mo., Marshall — City plans constructing and improving municipal light and power plant. $235,832. Applied for $106,124 grant and $129,708 loan from P.W.A. Contemplate issuing general obligation bonds for loan if approved. Henrici-Lowry Eng. Co., 114 West 10th St., Kansas City, engr.

Mo., Monett—City plans municipal light and power plant. Diesel engine generating equipment, etc. $145,205. Applied for $65,342 P.W.A. grant. L. W. Adams, city engr.

Mo., Mountain Grove—City, W. H. Balkely, mayor, plans light and power plant. $128,200. Applied for $57,690 P.W.A. grant. C. N. Garrison, Mountain Grove, engr.

Mo., Poplar Bluff — City plans improving waterworks and light plant. $40,000. Applied for $18,000 grant from P.W.A. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, engrs.

Mo., Shelbina—City, L. B. Henderson, mayor, plans generating unit for municipal light and power plant. $36,500. Applied for $15,000 P.W.A. grant. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., Stanberry — City plans constructing power plant, incl. Diesel engine power. $100,-000. Will apply for P.W.A. funds. Henrici-Lowry Eng. Co., 114 West 10th St., Kansas City, engrs.

Mo., St. Charles—City plans light and power plant with Diesel engine generating equipment, etc. $65,000. Applied for $29,250 P.W.A. grant. Russel & Axon, 4903 Delmar Blvd., St. Louis, engrs.

Mo., St., Louis—Laclede Power & Light Co., 1017 Olive St., plans rein.-con., steel addition to power plant, incl. two 15,000 kw. generators. Mound and Wharf Sts. $1,500,000 to $2,000,000. **Maturity indefinite.** Management & Engineering Corp., 327 South La Salle St., Chicago, Ill., and 900 South Boyle Ave., St. Louis, engrs.

Neb., Bostwick—Lower Republican River Power Project & Irrigation Dist. plans power and irrigation development. $1,500,000 Applied for P.W.A. funds. C. Mickey, Lincoln, engr.

Neb., Cambridge—United Power Project & Irrigation Dist. plans power plant and irrigation project. $945,455. Applied for P.W.A. funds.

Neb., Imperial—City plans electric light and waterworks improvements. $66,750. Applied for P.W.A. funds. Henningsen Eng. Co., Union State Bank Bldg., **Omaha, engrs.**

N. Y., Bayville—Plans constructing well, pumping equipment and elevated tank. $45,000. Applied for P.W.A. funds. S. B. Bowne, Mineola, civil engr.

N. Y., New Hyde Park—Village Bd. voted to construct municipal lighting plant. D. Holman, village counsel chn. of committee, making application to P.W.A. loan and grant of $300,-000. Clyde Potts, 30 Church St., New York, conducting engineer survey.

N. Y., New York—City, F. H. LaGuardia, mayor, plans election Nov. 5 to vote on proposition to construct municipal power plant. $45,000,000.

N. Y., Valatie—Village, F. Glenn, mayor, plans by L. L. Landt, engr. and archt., Valatie, constructing 500 hp. power plant, and 70x500 ft. warehouse. Columbia Co. $109,156. Applied for P.W.A. funds.

N. C., Southport—Town, c/o R. E. Mintz, clk., filed application with P.W.A. for loan for constructing new electric light plant, 350 additional hp.

O., Conneaut—City plans electric light plant and distribution system, $248,000; gas manufacturing system, $440,000. Application to P.W.A. for outright grant of $309,600 and loan of $378,400.

O., Crooksville—Ohio Power Co., Ironton, plans erecting 25,000 kw. transformer bank doubling capacity of Crooksville substation. $100,000.

O., Fairport—Village plans electric plant. $334,240. Village would pay $183,000 under present plans.

Okla., Isabel—City plans municipal light plant. $140,000. Applied for P.W.A. funds. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Bristow—City plans municipal light plant. $284,000. Applied for P.W.A. funds. P. S. Donnell, Federal Bldg., Oklahoma City, engr.

Okla., Nowata—City plans municipal light plant. $200,000. Applied for P.W.A. funds. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Mooreland—City, E. P. Van Frank, chn., bids about Oct. 17, electric light and power plant. $7,532 grant allotted by P.W.A. Benham Eng. Co., 212 Perrine Bldg., Oklahoma City, engrs.

Pa., New Castle—City plans election in November to vote on $1,500,000 bonds for constructing municipal light and power plant. May apply for federal funds. G. Throop, city engr.

S. C., Aiken—Aiken Co., A. E. Yaun, chn. Bd. Comrs., Aiken, plans building complete hydro-electric plant, incl. dam and erecting equipment, on South Saluda River. $1,700,630. Applied for P.W.A. loan.

S. D., Armour—Northwestern Service Co., Huron, plans electric light and power plant. $100,000.

Tex., Cuero—Municipality, plans by Garrett Eng. Co., 300 Hughes St., Houston, electric light and power plant. $225,000.

Tex., Haskell—City, A. F. Thurman, mayor, plans municipal electric light plant, incl. entire operating system. $100,000. Applying for P.W.A. loan and grant. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

Tex., Port Lavaca—City, F. M. Dudgeon, mayor, plans municipal building and harbor improvements, incl. 2 story, 120x180 ft., mill type power plant, two 125 hp. gas engines, two 93.5 KVA generators, 20 ton ice plant, one 100 hp. boiler, refrigeration, cold storage, oyster and shrimp storage facilities, etc., at harbor and dock; canning factory for shrimp, etc., fertilizer factory, est. $190,000; P.W.A. funds allotted. Garrett Engr. Co., 300 Hughes St., Houston, and Port Lavaca, engrs.

Tex., Smithville—City, c/o J. C. Mills, mayor, filed application with P.W.A. for loan and grant to finance construction electric light and power plant. $175,000. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

Tex., Sulphur Springs—City, S. Gafford, mayor, filed application with P.W.A. for loan and grant to finance construction of electric light and power plant. $225,000. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

Tex., Texarkana—City, W. V. Brown, mayor, filed application with P.W.A. for loan and grant to finance construction municipal electric power plant. $872,000. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

Vt., Brandon—Municipality plans electric light and power plant. $150,000. R. Palmer, Holyoke, engr.

Va., Danville—Election Oct. 1, to vote on $1,513,000 P.W.A. bonds which with the $1,-237,990 grant will provide funds necessary to develop large hydro-electric source in Patrick County.

B. C., Cheakamus—J. P. Meehan & Co., Ltd., 207 West Hastings St., Vancouver, preparing plans for power development of 50,000 hp.

B. C., Chilliwack—Hope Power Light Co., Ltd., plans plant. $25,000.

B. C., Terrace—Columbia Power Co. making plans diesel electric light and power plant. Leith Murray, engr.

Ont., Oakville—Municipality plans by George H. Power, diesel generating plant. $80,000.

Sask., Regina — W. J. Patterson, minister Natural Resources Dpt., plans three hydro-electric power developments at Old Man River, Jazin and Greare River, each about 40,000 hp.

Bolivia, Lake Titicaca — Government of Bolivia, LaPaz, Bolivia, hydro-electric poject at Lake Titicaca, to Hochschild Co., c/o M. Hochschild, LaPaz, or c/o Watson Geach & Co., 70 Pine St., New York, N. Y. Est. $25,000,000.